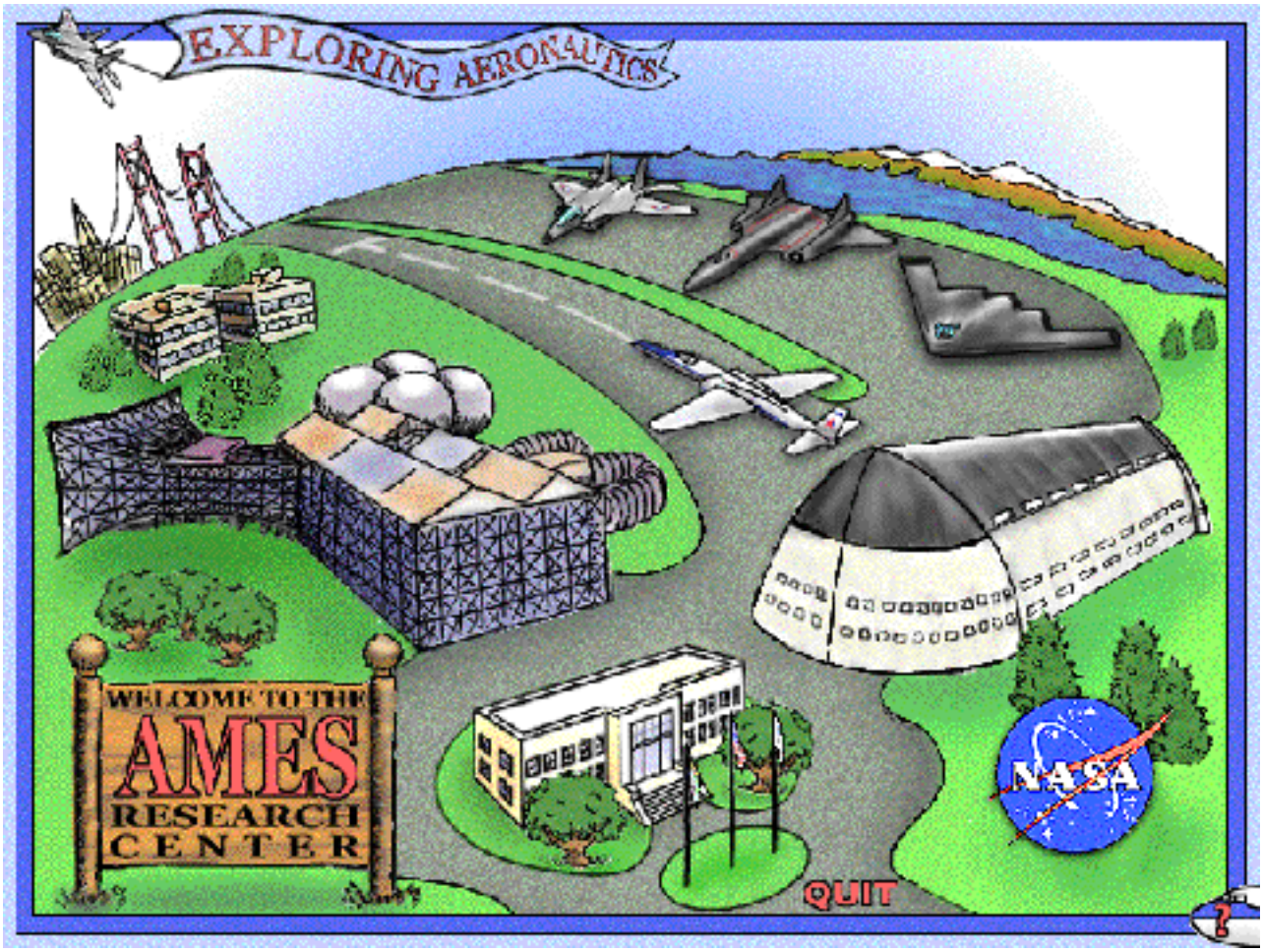
National Aeronautics and
Space Administration

Educational Product	
Educators	Grades 5-8

EG-2003-07-001-ARC

Exploring Aeronautics: The Science of Flight Educator Guide

An Educator Guide with Activities in Aeronautics



Part 1

aero-nau-tics \-iks\ n pl but sing in constr **1**: a science of dealing with the operation of aircraft **2**: the art or science of flight

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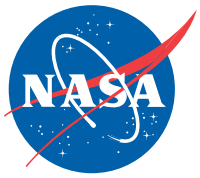
Exploring Aeronautics: The Science of Flight Educator Guide

Part I of the Three-Part Series



National Aeronautics and Space Administration
Office of Education

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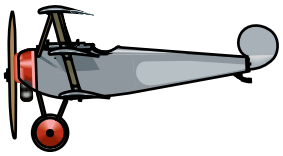


Acknowledgements

Susanne Ashby – Curriculum Specialist

Liza Alderete – Editor

Desktop Publishing Provided by
Gary Walton Graphics and Amberlee Chaussee

EXPLORING AERONAUTICS

Part I

Section 1

Introduction

Pedagogical Basis

Program Goals

1. To stimulate and increase student awareness of, interest in and achievement in science. Specifically, to stir young people's imagination and fuel their enthusiasm for the study of science, mathematics and technology using fundamental themes of aeronautics.

2. To engage students in interactive multimedia learning activities that increase their understanding of aeronautics-related concepts.

Goals and Objectives

Goal 1

To use the Scientific Method to answer a question or solve a problem.

Objectives

The Learner will be able to:

- recite the steps of the scientific method
- develop each part of the scientific method
- identify a question
- identify a hypothesis
- construct an experiment
- list procedures which will complete the experiment
- list material needed to perform the experiment
- perform experiment
- observe and record results
- write a conclusion
- identify a new question generated by the experiment

Goal 2

To understand that the progression of the science of aeronautics was influenced by the technology of the time and historic events, as well as individuals, agencies and groups who worked to solve problems.

Objectives

The Learner will be able to:

- gather information from a variety of resources (handouts, CD-ROM programs, encyclopedia, Internet, library print material and timelines)
- identify important aspects of aeronautical history with respect to five specified categories
- chronicle important events, discoveries and innovations in aeronautics using a timeline format

Goal 3

To understand that there are a variety of aircraft types which have been designed for specific purposes.

Objectives

The Learner will be able to:

- identify and describe the basic categories of aircraft
- identify features of an aircraft and then categorize that aircraft based upon those features
- identify and describe the regimes in which aircraft fly
- compare aircraft based upon their characteristics
- compare aircraft types based upon their regime
- define the speed of sound
- describe the phenomenon of flight
- identify and describe how sound travels in waves

Goal 4

To understand the four forces and their effect on aircraft.

Objectives

The Learner will be able to:

- name and define each of the four forces that influence flight
- describe the effect of each of the four forces upon an aircraft
- identify how the four forces work in an oppositional manner
- define a force

Goal 5

To understand the relationship between the shape of an airfoil and the four forces.

Objectives

The Learner will be able to:

- draw and label an airfoil and indicate airflow
- describe how air pressure is affected by airflow
- describe how air pressure influences lift

Goal 6

To understand the control surfaces and motions of an airplane.

Objectives

The Learner will be able to:

- identify and demonstrate the six motions of an airplane
- identify the three axes that help to define the motions of an airplane
- identify and label the control surfaces of an airplane
- demonstrate the movement which occurs as each control surface is manipulated, both individually and together

Goal 7

To understand what tools engineers and scientists use to test aircraft designs and how these tools are employed.

Objectives

The Learner will be able to:

- list the four tools of aeronautics
- describe how each tool works
- identify the importance of testing aircraft with these tools
- contrast modern tools to early tools
- discuss the importance of each tool to aircraft design

Goal 8

To understand how aeronautics has become an integral part of our modern world.

Objectives

The Learner will be able to:

- identify the varied uses of aircraft in our society
- identify occupations associated with aeronautics
- describe new aircraft designs being considered for future development

Correlation to National Science Education Standards

(National Science Education Standards, National Academy of Sciences, National Academy Press, 1996)

Unifying Concepts and Processes

- Systems, order and organization
- Evidence, models and explanation
- Form and Function

Content Standard A: Science as Inquiry

Students should develop abilities necessary to do scientific inquiry.

- Identify questions that can be answered through scientific investigations.

Students should design and conduct scientific investigation.

- Use appropriate tools and techniques to gather, analyze and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions. Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Students should develop understandings about scientific inquiry.

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of inquiry.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of their investigation.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Science advances through legitimate skepticism.
- Scientific investigations sometimes result in new ideas and phenomena for study....

Content Standard B: Physical Science

All students should develop an understanding of motions and forces.

- The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.
- An object that is not being subjected to a force will continue to move at a constant speed and in a straight line.
- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

Content Standard E: Science and Technology

All students should develop understandings about science and technology.

- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal.
- Perfectly designed solutions do not exist.
- Technological designs have constraints.
- Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.

Content Standard F: Science in Personal and Social Perspectives

All students should develop an understanding of science and technology in society.

- Science influences society through its knowledge and world view.
- Societal challenges often inspire questions for scientific research ….
- Technology influences society through its products and processes.
- Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.
- Scientists and engineers work in many different settings ….

Content Standard G: History and Nature of Science

All students should develop an understanding of science as a human endeavor.

- Women and men of various social and ethnic backgrounds engage in the activities of science, engineering ... Some engineers work in teams, and some work alone, but all communicate extensively with others.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

All students should develop an understanding of the Nature of Science.

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists.

All students should develop an understanding of the History of Science.

- Many individuals have contributed to the traditions of science.
- In historical perspective, science has been practiced by different individuals in different cultures.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

Content Matrix

Science Discipline	Physical
Grade Level	5 - 8
Theme(s)	Systems and Interactions; Forces and Motions; Scale and Structure; Structure and Function
Unifying Concept	The use of scientific inquiry has led humankind to develop an understanding of the forces and motions that enable flight.
Grade Level Concept	Forces acting on a structure in a particular way enable flight.
Subconcepts	Trial and error gave way to observation and scientific inquiry in the study of aeronautics; Four forces (lift, drag, weight, thrust) interact with special structures to achieve and maintain controlled flight; These forces and structures and their subsequent interactions can be observed for specific causes and effects.

Interdisciplinary Planning Web

Aeronautics Interdisciplinary Planning Web

Written Language
– Research:
- an aircraft and create a chart of the information
- an individual from the timeline
- types of drag
- in-depth information on one of the tools of aeronautics

– Pretend you are a part of a group of molecules and write a descriptive paragraph about a sound wave moving through your group
– Pretend you are an individual from the timeline and write a letter or journal entry telling about your work
– Take notes from an informational reading
– Create mind webs or content webs on information contained in each section

Student Reading
Strange and Wonderful Aircraft
– Harvey Weiss
Lost Star: The Story of Amelia Earhart
– Patricia Lauber
Flying Free: America's Black Aviators
– Philip S. Hart
The Tuskegee Airmen: Black Heroes of World War II
– Jaqueline Harris

Teacher Read Alouds
The Glorious Flight: Across the Channel with Louis Bleroit
– Alice & Martin Provensen
Flight
– Robert Burleigh
The Fool of the World and the Flying Ship
– re-told by Arthur Ransome

Oral Language
- Conduct a mock interview of a historical figure in aeronautics
- Be a reporter at an aeronautical "first" event and report on it
- Recite a poem with an aeronautical theme

Physical Education
- Create a dance that depicts the four forces of flight

Mathematics
- Measurement
- Calculate aeronautical formulae
- Calculate mach speeds
- Develop charts and graphs to organize information

Art
- Illustrate a historical event represented in the timeline
- Draw a technical diagram of a plane and label its parts
- Illustrate the airfoil of a commercial jet as it changes shape from takeoff to landing
- Create a relief sculpture showing airflow around a plane

Science
- Use the Scientific Method to solve a problem or answer a question
- Use research methods to solve problems

Music
- Compose a musical piece that reflects one of the following: the four forces, control surfaces, six motions on three axes
- Compose a rhythmical piece that demonstrates the four forces

Social Studies
- Create a timeline of specific aeronautical achievements, events or people
- Learn to access information from a timeline
- Debate the importance of some aeronautical achievements or aeronautical research

Multiple Intelligences Planning Web

Aeronautics Multiple Intelligences Planning Web

Linguistic

- CD-ROM *Exploring Aeronautics* on screen text & narration
- Writing Prompts:
  - Pretend you are a wing; describe how you generate lift
  - Pretend you and your friends are molecules experiencing a sound wave
  - Write a cinquain or a ballad about a historical aeronautical event that is featured in the Timeline section of the CD
  - Pretend you are a model being tested in a wind tunnel; describe your experience using aeronautical language
  - Write a song that teaches about the four forces
- Literature Books:
  - The Fool of the World and the Flying Ship
  - The Glorious Day
  - Flight
- Comparison Chart:
  - Aircraft Types
  - Wing Shapes
- Debate
  - Debate the importance of aeronautical research to society

Logical-Mathematical

- Graph the four forces
- Compute the aspect ratio of wings Take averages of wind tunnel test results for lift and drag
- Measurement: Creating a Timeline

Spatial

- Introduce new concepts with trans-parencies of appropriate graphics
- CD-ROM *Exploring Aeronautics* :
  - QTVR in Hangar section
  - Airfoil: Lift and Drag Activity
  - Timeline
- Diagram the following:
  - airflow over wing
  - four forces in flight
  - wind tunnel
  - angle of attack
- Make a model
  - paper airplanes with working control surfaces
- Design a Patch about a specific aeronautical event found in the History section of CD
- Create a Concept Map:
  - four forces
  - tools of aeronautics
  - wing shape
  - aeronautics
  - aviation
- Create a trading card about an aircraft type of your own choice
- Create a bulletin board of an aeronautical
- concept of your own choice
- Create a flip-book that demonstrates airflow over a wing

Intrapersonal

- CD-ROM *Exploring Aeronautics* student choice
- Choose an aviation event on which to do research
- Develop a presentation for display during an air show
- Create an interest or learning center:
  - aircraft type of your choice
  - one of the tools of aeronautics
- Create a set of note cards on a topic of student's choice

Interpersonal

- CD-ROM *Exploring Aeronautics*
- Create a multimedia presentation on an aeronautical concept of student's choice
- Create a working model of an airplane by using peers for the parts and control surfaces of the model
- Create and direct a skit about an aeronautical concept
- Research and write a radio interview with a historical figure from the aeronautic timeline
- Work in cooperative groups or partnerships to perform an experiment dealing with an aeronautical concept

Bodily-Kinesthetic

- Glider/Control Surfaces Activity
- Create a model of an airplane using material of student's choice
- Experiments:
  - Moving Air Exerts Pressure
  - Moving Air and Changes in Pressure
  - What a Drag
  - The Force of Thrust
  - A Little Lift
  - Lift and an Airfoil
- Create an airflow sculpture
- The Big Event: Air Show
- Design a paper airplane

Musical

- Create a song about the four forces
- Create a dance that demonstrates the four forces, airplane movements, or control surfaces.
- Create music to accompany another presentation about aeronautics

Multiple Intelligences Culminating Activities

Logical-Mathematical
Create a paper airplane designed to fly a great distance. Set up a course and perform flight tests, measuring the distance of each flight, developing a chart and graph of results, and then figuring the average flight distance.

Spatial
Create a sculpture with the theme of flight.
Create a mind map about one of the following: aircraft, aeronautics, aeronautical tools.

Musical
Write a song, rap or instrumental piece that expresses an aspect of flight or aeronautics.

Body-Kinesthetic
Create a dance that demonstrates one of the fundamentals of aeronautics or an aspect of flight.

Interpersonal
Create a working airplane using people to form the parts. Have them coordinate their movements to fly like an airplane.

Intropersonal
Choose an aspect of aeronautics that you enjoyed learning about and research that topic on the Internet or a CD-ROM, then present your findings to a small group of interested students.

Linguistic
Choose one position from below and write a letter to a politician attempting to inform and influence his/her opinion in regards to this topic:

- importance of research to aeronautics;
- importance of aeronautics to our modern society;
- supersonic flight and regulations;
- flight safety.

Aeronautics Thematic and Topical Questions
Evidence, Models and Explanation
Systems, Order and Organization
Form and Function
Aeronautics
Aeronautical Research
How an Airplane Flies
Types of Airplanes
History of Aeronautics
What questions are answered and what problems are solved through the use of these research tools?
How are the four tools of aeronautics used to investigate, test, gather, analyze and understand the science of flight?
How is each tool used to perform aeronautical research?
How is lift generated?
How do the parts and control surfaces work to affect flight?
How does an airfoil contribute to lift?
How is the airplane's design related to the work it performs?
How are the laws of aeronautics different for subsonic and supersonic flight?
What information has been gathered from research prototypes?
In what ways have airplane designs changed through the years?
What are the laws and principles that comprise the knowledge base of aeronautics?
What are the significant contributions of aeronautical research to the science of flight?

Using the Unit

Suggested Daily Lesson Planner

You might be asking yourself, "Where do I begin with this unit?" What follows is a suggested daily plan for the unit. Use this as a guide and substitute activities as the needs of your class dictate.

Day 1

- Do *Opening Set*
- CD-ROM Component: Demonstrate the interface and discuss what kind of information is found on the CD-ROM as well as how to navigate and access information.

Day 2 - Introduction to Aeronautics

- Read *Teacher Reading*.
- Use the *Overhead Guide* to introduce the topic of aeronautics.
- Distribute *Student Note Taking Guide* with the details side blanked out.
- Read aloud the *Student Reading*. After each paragraph, guide the students in the note taking process.
- After discussion, distribute the *Student Worksheet: Aeronautics*.
- CD-ROM Component: Allow students to "explore" only "The Resource Center" section.

Day 3 - The Scientific Method

- Read *Teacher Reading*.
- Introduce the Scientific Method.
- Introduce and discuss each step of the Scientific Method. Use either the *Student Guidesheet* or *Abbreviated Student Guidesheet*.
- Perform the *Teacher-Led Experiment: Balloon Thrust*. Have students fill in their *Experiment Log* as you perform each step of the Scientific Method.
- Have students complete the *Student Worksheet: The Scientific Method*.
- CD-ROM Component: Assign from the Student Logbook the worksheet "The Firsts in Flight" and have the students use the "History" subsection of "The Resource Center".

Day 4 - The Scientific Method (continued)

- Have the students read the *Student Reading: Newton's Third Law.*
- Review the Scientific Method.
- Walk the students through the Teacher-Led Experiment: The Cup with Water. Have students fill in their Experiment Log as you perform each step of the Scientific Method.
- CD-ROM Component: Assign from the Student Logbook the "Glossary Search" activity sheet and have the students use the "Glossary" subsection of "The Resource Center".

Day 5 - Fundamentals of Aeronautics

- Read *Teacher Reading*.
- Use the *Overhead Guides* to help illustrate the information presented in the *Student Reading*.
- Hand out the *Student Reading* and the corresponding *Student Note Taking Guide* with the details side blanked out.
- Read aloud, discuss and take notes from the *Student Reading*.
- Have students complete the *Student Reading Worksheet: The Four Forces*.
- CD-ROM Component: Assign from the Student Logbook "The People of Flight" and use the "History" subsection of "The Resource Center".

Day 6 - Fundamentals of Aeronautics (continued)

- Review the information from yesterday's readings.
- Go over procedures for the experiment: *Faster Air = Lower Air Pressure I*.
- Hand out Procedure Card and blank Experiment Log (use *Experiment Log Template*) and have students do the experiment.
- Review student experiment logs and compare with Experiment Log Key, modeling what a well-written hypothesis and conclusion look like.
- CD-ROM Component: Assign from the Student Logbook the activity sheet "Four Forces" and use the "How an Airplane Flies" section's "Lift" and "Four Forces" subsections.

Day 7 - Fundamentals of Aeronautics (continued)

- Go over procedures for the experiment: *Faster Air = Lower Air Pressure 2*.
- Hand out Procedure Card and blank Experiment Log (use *Experiment Log Template*) and have students do the experiment.
- Review student experiment logs and compare with Experiment Log Key, modeling what a well-written hypothesis and conclusion look like.
- CD-ROM Component: Assign from the Student Logbook the "Word Hunt" activity sheet and use the "Glossary" subsection of "The Resource Center".

Day 8 - Fundamentals of Aeronautics (continued)

- Go over procedures for the experiment: *What A Drag!*
- Hand out Procedure Card and blank Experiment Log (use *Experiment Log Template*) and have students do the experiment.
- Review student experiment logs and compare with Experiment Log Key, modeling what a well-written hypothesis and conclusion look like.
- CD-ROM Component: Assign from the Student Logbook the activity sheet "Dates in the History of Flight" and use the "History" subsection from "The Resource Center".

Day 9 - Fundamentals of Aeronautics (continued)

- Go over procedures for the experiment: *The Force of Thrust*.
- Hand out Procedure Card and blank Experiment Log (use *Experiment Log Template*) and have students do the experiment.
- Review student experiment logs and compare with Experiment Log Key, modeling what a well-written hypothesis and conclusion look like.
- CD-ROM Component: Assign from the Student Logbook the activity sheet "Prefix" and "Where in the World Did *THIS* Word Come From?" and use the "Glossary" subsection of "The Resource Center".

Day 10 - Fundamentals of Aeronautics (continued)

- Go over procedures for the experiment: *A Little Lift*.
- Hand out Procedure Card and blank Experiment Log (use *Experiment Log Template*) and have students do the experiment.
- Review student experiment logs and compare with Experiment Log Key, modeling what a well-written hypothesis and conclusion look like.
- CD-ROM Component: Assign from the Student Logbook "The Aircraft" and use the "History" subsection of "The Resource Center".

Day 11 - Fundamentals of Aeronautics (continued)

- Choose some of the activities from *Additional Student Activities*.
- CD-ROM Component: Allow the students to thoroughly explore "The Hangar" section.

Day 12 - Fundamentals of Aeronautics (continued)

- Choose topics from *Writing Experiences* and have students share their essays.
- CD-ROM Component: Assign from the Student Logbook "Technology and Aeronautics" and use the "History" subsection of "The Resource Center".

Day 13 - Wings

- Read *Teacher Reading*.
- Hand out *Student Reading* and *Note Taking Guide* for *Part 1.*
- Use the *Overhead Guides* to illustrate information presented as you read aloud, discuss and take notes.
- Have students complete the *Student Worksheet* for *Part 1*.
- CD-ROM Component: none

Day 14 - Wings (continued)

- Hand out *Student Reading* and *Note Taking Guide* for *Part 2.*
- Use the *Overhead Guides* to illustrate information presented as you read aloud, discuss and take notes.
- Have students complete the *Student Worksheet* for *Part 2.*
- CD-ROM Component: none

Day 15 - Wings (continued)

- Go over procedures for the experiment: *Lift and An Airfoil*.
- Hand out Procedure Card and blank Experiment Log (use *Experiment Log Template*) and have students do the experiment.
- Review student experiment logs and compare with Experiment Log Key.
- CD-ROM Component: Assign from the Student Logbook the activity sheet "Lift" and use the "Lift" subsection of the "How an Airplane Flies" section.

Day 16 - Wings (continued)

- Choose some of the activities from *Additional Student Activities*.
- CD-ROM Component: Assign from the Student Logbook the activity sheet "Wing Shape" and use the "Wing Shape" subsection of the "How an Airplane Flies" section.

Day 17 - Wings (continued)

- Choose some of the activities from *Additional Student Activities*.
- CD-ROM Component: Assign from the Student Logbook the activity sheet "Pilot Clues" and use "The Hangar" section.

Day 18 - Wings (continued)

- Choose topics from *Writing Experiences* and have students share their essays.
- CD-ROM Component: none

Day 19 - Airplane Control

- Read *Teacher Reading*.
- Hand out *Student Reading* and *Student Note Taking Guide*.
- Use the *Overhead Guides* to illustrate information presented as you read aloud, discuss and take notes on the first half of the reading.
- CD-ROM Component: none

Day 20 - Airplane Control (continued)

- Complete reading and note taking for *Student Reading.*
- Use the *Overhead Guides* to illustrate information presented as you read aloud, discuss and take notes on the first half of the reading.
- Have students complete the *Student Worksheet: Airplane Parts and Motions*.
- CD-ROM Component: Assign from the Student Logbook the activity sheets "Parts" and "Control Surfaces" (first page only of latter) and use the "Parts" subsection of the "How an Airplane Flies" section.

Day 21 - Airplane Control (continued)

- Review *Procedure: Making Your Own Glider*.
- Have students make their own gliders.
- Have students complete the *Student Worksheet: Airplane Control*.
- CD-ROM Component: Assign from the Student Logbook the activity sheet "Control Surfaces" (second page) and "Movement" and use the "Movement" subsection of the "How an Airplane Flies" section.

Day 22 - Airplane Control (continued)

- Go over procedures for *Control Experiment #1.*
- Hand out Procedure Card and blank Experiment Data Sheet (use *Experiment Data Sheet Template*) and have students do the experiment.
- Review student experiment data sheets and compare with Experiment Data Sheet Key.
- CD-ROM Component: none

Day 23 - Airplane Control (continued)

- Go over procedures for *Control Experiment #2.*
- Hand out Procedure Card and blank Experiment Data Sheet (use *Experiment Data Sheet Template*) and have students do the experiment.
- Review student experiment data sheets and compare with Experiment Data Sheet Key.
- CD-ROM Component: none

Day 24 - Airplane Control (continued)

- Go over procedures for *Control Experiment #3.*
- Hand out Procedure Card and blank Experiment Data Sheet (use *Experiment Data Sheet Template*) and have students do the experiment.
- Review student experiment data sheets and compare with Experiment Data Sheet Key.
- CD-ROM Component: none

Day 25 - Airplane Control (continued)

- Review the results of the experiments done over the past three days with the students. Reiterate the name and location of each control surface and what motion it controls. Demonstrate each with your own glider. Have students reflect on their experiences over the past three days - how comfortable are they with the Scientific Method?
- CD-ROM Component: Assign from the Student Logbook the 2 activity sheets "Make Your Own Comparison" and use "The Hangar" section.

Day 26 - Airplane Control (continued)

- Choose topics from *Writing Experiences* and have students share their essays.
- CD-ROM Component: Assign from the Student Logbook "Experiment: Airfoil Lift and Drag" and use the "Activity Center" section.

Day 27 - Tools of Aeronautics

- Read *Teacher Reading*.
- Hand out *Student Reading* and *Student Note Taking Guide*.
- Use the *Overhead Guides* to illustrate information presented as you read aloud, discuss and take notes.
- Have students complete the *Student Worksheet: Tools of Aeronautics.*
- CD-ROM Component: Assign from the Student Logbook the activity sheet "Computational Fluid Dynamics" and use the "CFD" subsection of the "Tools of Aeronautics" section.

Day 28 - Tools of Aeronautics (continued)

- Go over procedures for *Experiment: Air Pressure and Current of Air.*
- Hand out Procedure Card and blank Experiment Log (use *Experiment Log Template*) and have students do the experiment.
- Review student experiment data sheets and compare with Experiment Log Key.
- CD-ROM Component: Assign from the Student Logbook activity sheet "Wind Tunnels" and use the "Wind Tunnel" subsection of the "Tools of Aeronautics" section.

Day 29 - Tools of Aeronautics (continued)

- Choose some of the activities from *Additional Student Activities*.
- CD-ROM Component: Assign from the Student Logbook activity sheet "Flight Simulation" and use the "Flight Simulation" subsection of the "Tools of Aeronautics" section.

Day 30 - Tools of Aeronautics (continued)

- Choose one of the activities from *Additional Student Activities.*
- CD-ROM Component: Assign from the Student Logbook activity sheet "Flight Test" and the "Flight Test" subsection of the "Tools of Aeronautics" section.

Opening Set

Pre-Set

- Make a plywood "glider" (which is not meant to fly). Take old plywood boards and sticks and construct a model that looks like an airplane, but does not function like one.
- Purchase a prefabricated balsa wood or Styrofoam glider.

Set

- Present each glider for class viewing. Pass the gliders around the classroom for closer inspection.
- Facilitate class discussion on a comparison of the models.
- Ask the class what they think enables an airplane to fly. List their ideas.
- In groups, have students create lists of the following:
    - What they already **know** about aeronautics;
    - What they **want to know**.
- Discuss these lists and compile them.
- Ask the class which "glider" will fly. Discuss their explanations.
- Attempt to fly each glider.
- Review predictions and explanations without offering technical explanations.

Post-Set

- Written reflection: Have students write their explanation of what enables an airplane to fly. Encourage them to express their explanation in two to four sentences and to make a diagram to illustrate their explanation.
- Additional reflection: Have the students create a mind web of aeronautics or airplanes. Save these in their portfolio and compare this initial mind map to one completed at the end of the unit.

The Big Event: Air Show

As an activity to culminate the aeronautics unit, teachers and students can conduct their own Air Show. Air Show events can include contests, an air museum, oral presentations, guest speakers and/or a "Fly By" performed by members of the class who have built their own glider. The following paragraphs detail how these events can be organized and run.

.

Air Museum

Utilizing pieces of work completed by students during the unit, have students design displays and set up the classroom as a museum. Some suggestions for display titles are as follows: Art and Aeronautics, The History of Aeronautics, Aircraft, Fundamentals of Flight, People of Flight.

Oral Presentations

Have students present poems, songs/raps, creative writings or interviews to classmates or to other classes as part of a school-wide special event. The presentations could be recorded on videotape for viewing by parents and teachers at an appropriate event.

Guest Speakers

Invite community members involved in aeronautics to give a 15-30 minute talk about their work. Have the students design the invitations and thank you notes.

Potential Guest Speakers

- aeronautical engineer involved in aerodynamics, avionics, instrumentation, materials manufacturing
- pilot
- parachutist
- aeronaut
- air traffic controller
- airport operations manager
- airplane mechanic
- flight attendant
- scientist involved in metallurgy, composites and ceramics used in aircraft manufacture
- aircraft manufacturing employee involved in sheet metal, fabrication, assembly, inspection, pattern making, molding

Air Show Guest Speaker Guidelines

Date _____

Dear _____,

Thank you so much for taking the time to join us as a speaker for our "Air Show" as we conclude our study of aeronautics. To help you prepare for your presentation we have included some helpful hints as well as a suggested outline. Feel free to follow the presentation outline or modify it as you wish. We look forward to your visit on month-date-day.

Hints

- Any visuals you could bring with you would be very interesting, for example: photographs, models, actual tools and/or parts, short videotape clips.
- If you need any special equipment (microphone, VCR-TV, computer, audio tape player) let us know in advance so we can have it ready for you.
- If you wear a special uniform, it would be really nice to see it.
- Keep your presentation to 15 - 20 minutes.
- Allow time for questions after your presentation is completed.

Presentation Outline

1. Introduce yourself

- Give your name.
- What is your relationship to someone in our class or at our school?
- Where and for what company do you work?
- How long have you worked there?
- Have you worked in any other jobs that were related to aeronautics?

2. Tell about your job

- What is your job title?
- Give your job description.
- What is your job's relationship to aeronautics?

3. Describe a typical workday

- When do you start work and end work?
- What are some of the usual things you have to deal with every day?
- Do you work with any special tools or machines on your job?
- What part of your job do you like the most?
- What part of your job do like the least?

4. Related job Information

- What kind of training or schooling do you need to do this work?
- Why did you go into this type of work?

5. Questions

- Leave about 5 minutes for questions.

Contests

Presented below are two contests which can be judged and/or monitored by parents or perhaps by some of the guest speakers. The two contests are the "Glider for Distance" and the "Slowest Parachute Drop." Charts for both contests and directions for making the launcher follow these instructions.

1. Glider for Distance

Pre-contest

The gliders can be either styrofoam gliders or paper gliders. Students can be given class time to construct gliders or they can construct them at home. Students can use a pattern provided by the teacher or may find/create their own.

Construct a launcher according to the directions below. Allow students a few days prior to the contest to use the launcher to practice launching their planes.

Set-up

Find a long room that does not have drafts. Set out two parallel strings about 3-4 meters apart along the length of the room. This is to keep students clear of the landing zone. Set a small table or desk at one end of the course. This becomes the takeoff point upon which the launcher will sit.

Make sure you have a very long tape measure and one student or parent who can make the measurements - the "measuring judge". Have another student or parent be the "spotter." This person's job is to spot where the plane first lands (touches the ground) and mark the spot for measurement. The spotter can also assist the measuring judge. The results should be recorded on the distance chart.

The Contest

Give each student one practice launch and then two actual launches. Measure the latter two launches and record both measurements. As prizes you can award students model airplane kits, balsa wood gliders or other flying toys or objects (patches, stickers, etc.).

2. Slowest Parachute Drop

Pre-contest

Purchase bolts - one for each student. They should be heavy enough to pull down lightweight cotton material. Instruct students to gather the material for their parachute and some "string". The string can be yarn, twine, fishing line, or thread. The selection of the size, shape and type of cloth as well as the type of "string" should be left to the students. They should base their decisions on the size and weight of the bolt you give them.

Have the students think about how they will build their parachute and plan the construction. Have each student assemble their own parachute before the contest. Allow them only a certain amount of time for construction.

Contest

Using a ladder, have an adult hold the center of the parachute and release it from a predetermined height. It is recommended that the drop be held at a height between 3 and 5 meters. Have another adult time the descent with a stopwatch and record the time.

Slowest Parachute Drop Chart

Student's Name	Drop 1	Drop 2	Slowest Drop	Overall Standing

Launcher

Materials for Construction

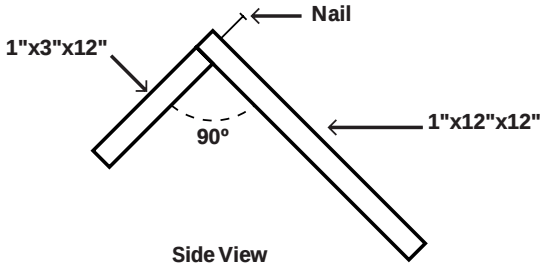
1 piece of wood 1” x 12” x 12”
1 piece of wood 1” x 3” x 12”
4 - 1-inch nails
hammer

Materials for Launch Use

1 oversized rubber band
1 ruler

Directions for Construction

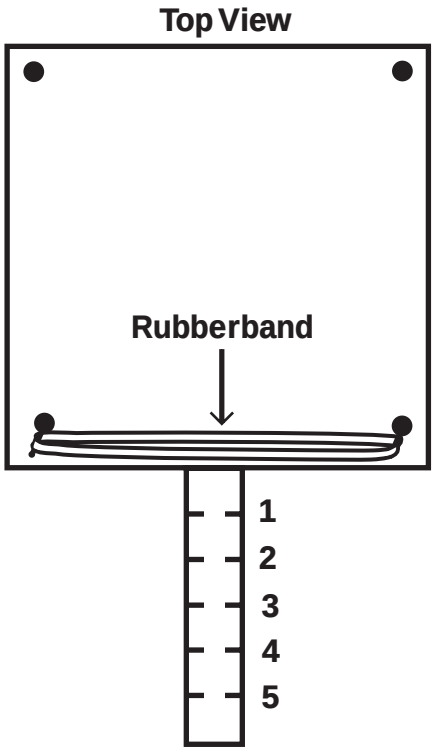
1. Connect the smaller board (1” x 3” x 12”) to the larger board (1” x 12” x 12”) with two 1-inch nails at a 90-degree angle as per the drawing below.



2. Nail the other two 1-inch nails into the “lower end” of the larger board (1” x 12” x 12”) approximately 1 inch in from the side and a half inch above the end as per the drawing below, making sure that you leave about one-half inch of each nail exposed.

3. Loop the oversized rubber band around the nails.

4. When preparing to launch a glider, place a ruler under the launcher so that “student pilots” all pull back on the rubber band to the exact same length. The length should be set between 3” - 7” depending upon the size of the rubber band. This will standardize the launch procedure.



Assessment

Introduction

As with any educational guide some type of assessment is always in order. There are many ways to assess a student's learning achievements. This section attempts to provide the instructor with a variety of assessments which can be easily adapted to accommodate almost any curriculum model being used in the classroom. Some of these assessments can be embedded throughout the Science of Flight Unit, while others can be used as specific benchmarks along the way. These assessments attempt to incorporate the various ways students express their knowledge of scientific concepts, as well as enable them to display their ability to use scientific processes. This collection of assessments is meant to complement what is already being done in your classroom. It includes a variety of embedded, pictorial, performance task, reflective, self-evaluative and traditional assessment experiences. It is hoped that teachers find this variety of assessments to be useful during the assessment process.

Introductory Assessments

Introductory assessments can be used to determine what students already know about a subject or what misconceptions they might have, and assist in constructing a more accurate learning base. They help the teacher build instructional experiences to ensure that students acquire the necessary skills, concepts and processes. Introductory Assessments can be brought full circle at the conclusion of a unit to demonstrate for students how much learning they have done.

Know-Want to Know-Learned-Proof of Learning

This is a variation of the standard "Know-Want to Know-Learned" method - "Proof of Learning" added as a fourth component.This activity can be done as a group assessment or can be done individually and placed in each of the student's portfolios to be used at the end of the unit as a final assessment tool.

At the beginning of the unit, the first page of the chart should be handed out with the question, "What do you know about how an airplane flies?" Students should list 3 - 5 statements about what they already know about aeronautics and write their answers in the "Know" box. This is followed by the question, "What more do you want to know about how airplanes fly?" Students should list 3 - 5 questions that they would like answered about aeronautics and write their responses in the "Want to Know" box. A class discussion should be facilitated to give the teacher an idea of what gaps and misconceptions students have in their knowledge, as well as what aspects of aeronautics intrigue them.

At the end of the unit, the students can retrieve their completed first page and be presented with the second page. Have the students state specifically, three to five "big ideas" in the "Learned" box. These could be answers to the questions listed at the beginning of the unit. Finally, have them offer proof of learning in the "Proof of What I Learned" box. For example, they might have learned that airfoils help make planes fly. They could then explain Bernoulli's principle to give evidence.

Aeronautics K-W-L-P Assessment

Page 1

Know

Want to Know

Aeronautics K-W-L-P Assessment

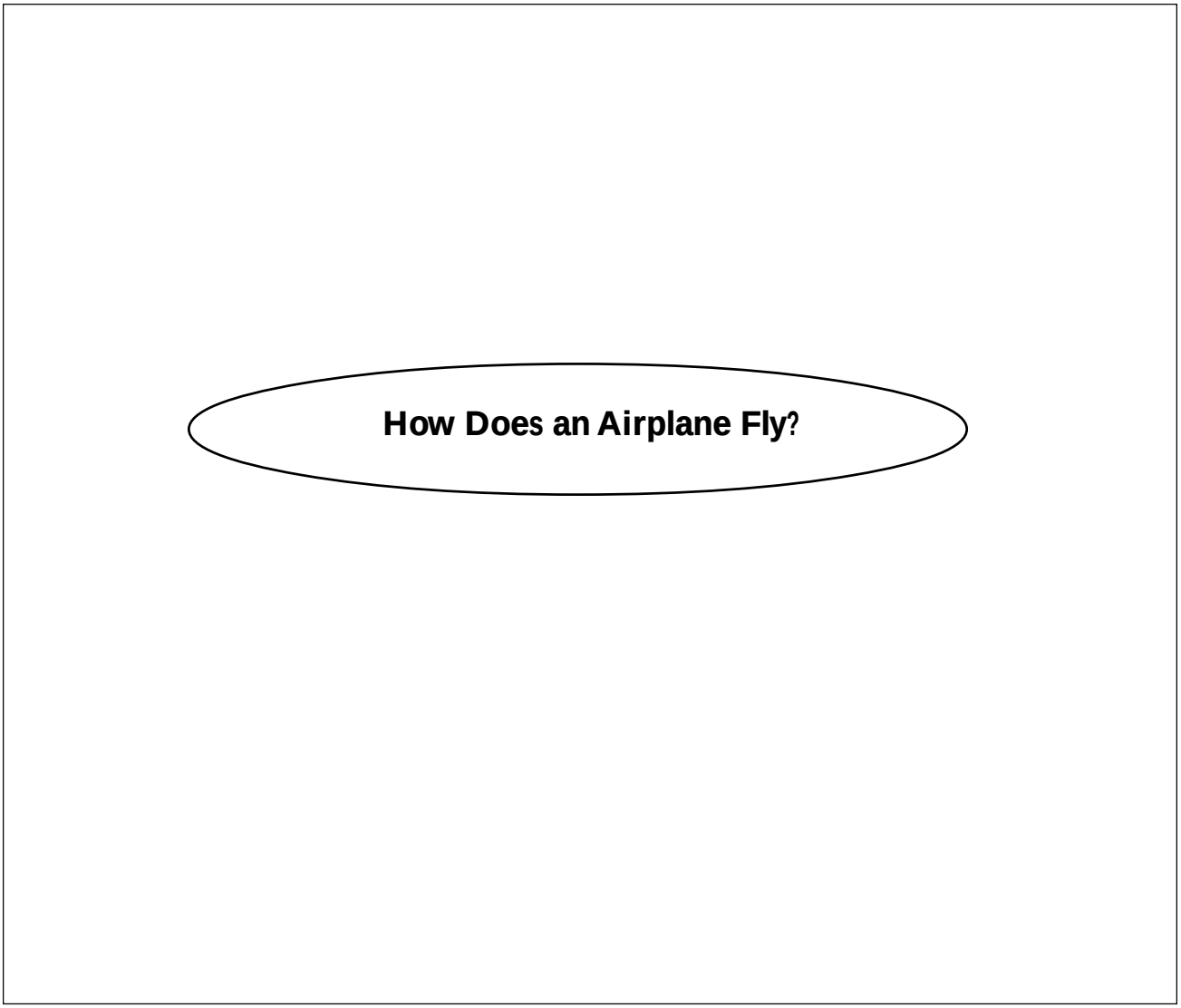
Page 2

Learned

Proof of What I Learned

Brainstorming

Have students write the question: "How does an airplane fly?" in the center of a piece of paper. Give them time to write down their ideas in answer to the question. The ideas do not have to be complete sentences! If any ideas have an intuitive connection then a line should be drawn between those that do. At the end of the unit, repeat this activity. A comparison between the results of the pre- and post- activities can graphically demonstrate how much learning has taken place.



Exploring Aeronautics
Pre-Test

Directions: This test will show what you know about aeronautics already. You will not be graded on this pre-test. It will be used to compare what you know now about aeronautics to what you will have learned by the end of the unit. Even though you might not know some of these answers, do your best to answer each question below.

1. Name the four forces that act on an airplane.

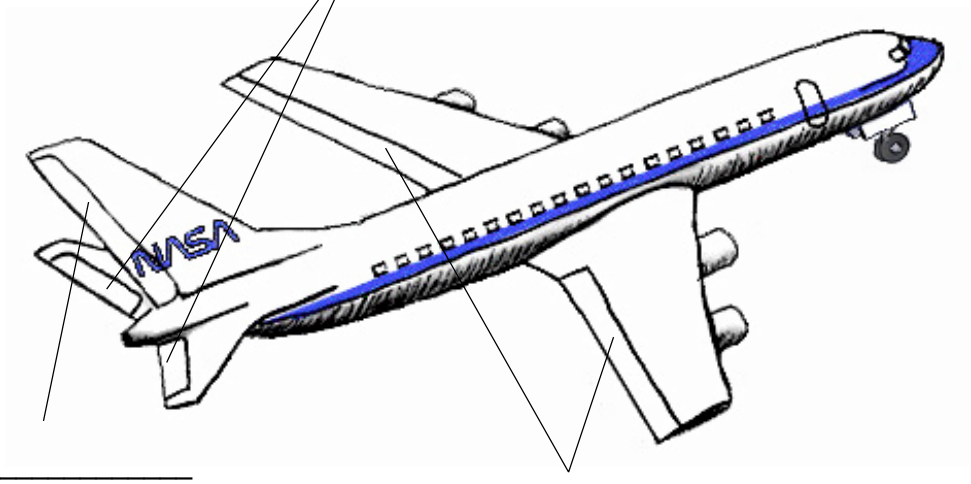
2. In your own words define aeronautics.

3. List the steps you would take to find the answer to a question or to solve a problem.

4. Name one important aeronautical event in history that improved the science of aeronautics. Explain how it improved aeronautics.

5. In the box below, draw a diagram that shows how a wing generates lift. Include these labels on your diagram: airfoil, airflow, high pressure, low pressure, lift.

6. On the diagram below, label each control surface and then tell what motion it affects.



1. _____ motion:_____

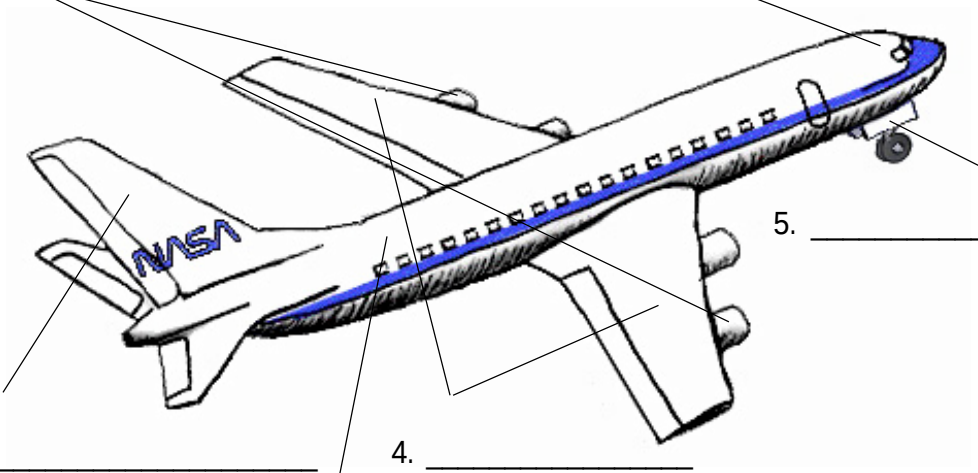
2. _____
motion:_____

3. _____
motion:_____

7. Name one tool of aeronautics and explain how it is used to test an aircraft design.

8. Explain how computers are used in aeronautical research.

9. Label the parts of the airplane in the diagram below.



10. Explain the differences between a straight wing airplane design and a delta wing airplane design.

Exploring Aeronautics
Pre-Test
Answer Key

Directions: This test will show what you know about aeronautics already. You will not be graded on this pre-test. It will be used to compare what you know now about aeronautics to what you will have learned by the end of the unit. Even though you might not know some of these answers, do your best to answer each question below.

1. Name the four forces that act on an airplane.

- *Lift*
- *Weight*
- *Thrust*
- *Drag*

2. In your own words define aeronautics.

Answers will vary, but should include the basic statement written below:
The study of flight and the science of building and operating an aircraft.

3. List the steps you would take to find the answer to a question or to solve a problem.

The Scientific Method should include steps like the following:
- *Identify or state the problem*
- *Form the hypothesis*
- *Design an experiment: materials list and procedures*
- *Perform or do the experiments*
- *Organize and analyze the data*
- *Draw your conclusions*

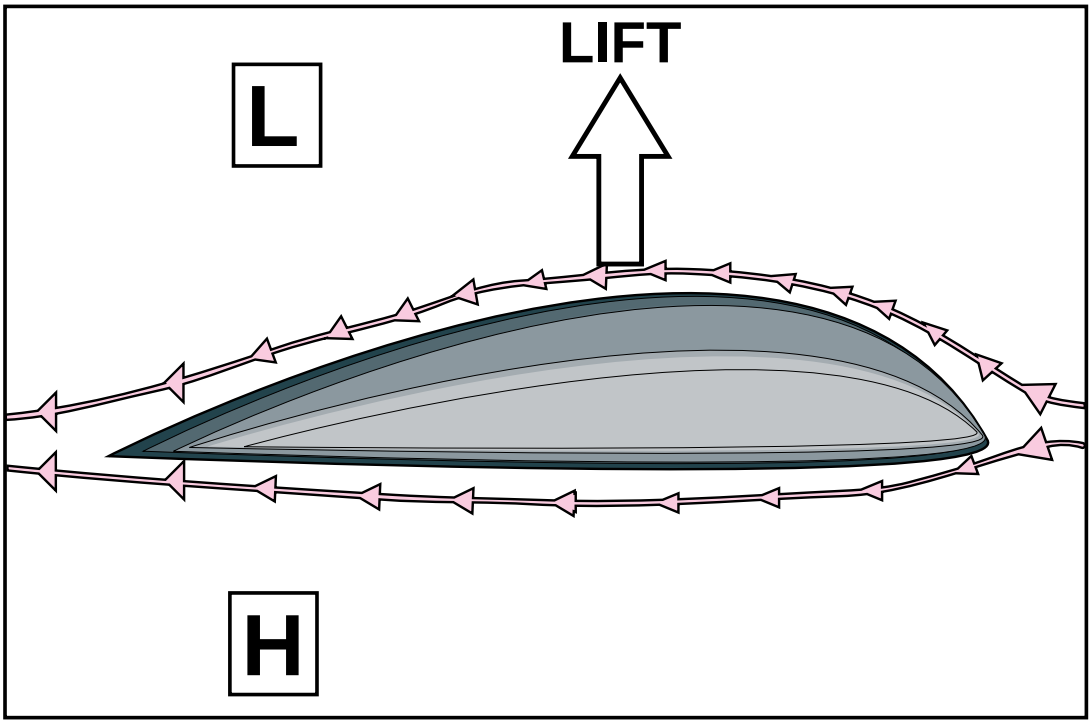
4. Name one important aeronautical event in history that improved the science of aeronautics. Explain how it improved aeronautics.

Answers will vary, but one example is listed below:

The early drag research done on propellers in 19 — changed the design of propellers on airplanes. The previously exposed engine parts were covered with a "cowling" that made the air flowing around the nose of the airplane follow a smoother pathway. This reduced drag and made the fuel consumption more efficient.

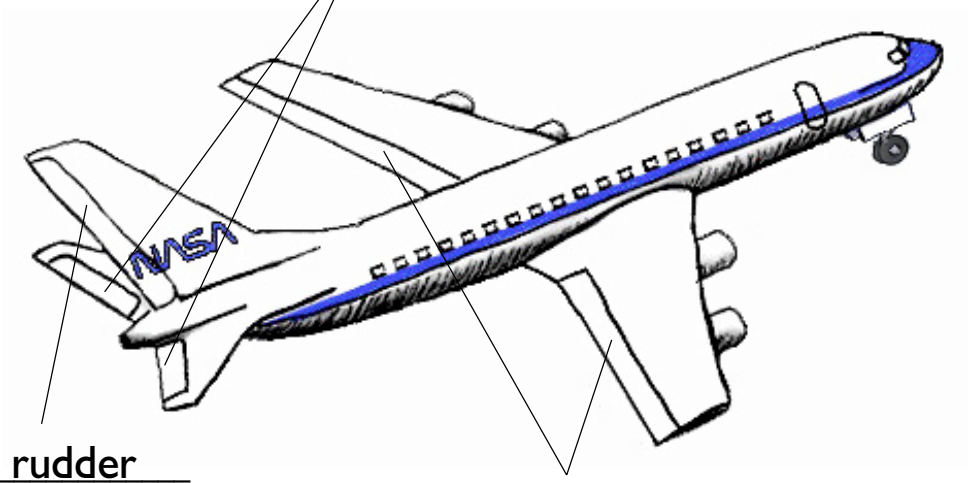
5. In the box below, draw a diagram that shows how a wing generates lift. Include these labels on your diagram: airfoil, airflow, high pressure, low pressure, lift.

AIRFLOW IS FASTER OVER THE TOP OF THE WING
THUS THE **LOWER** AIR PRESSURE



AIRFLOW IS SLOWER UNDERNEATH THE WING THEREFORE
THE AIR PRESSURE IS GREATER/**HIGHER**

6. On the diagram below, label each control surface and then tell what motion it affects.



1. elevators motion: pitch

2. rudder
motion: yaw

3. ailerons
motion: roll

7. Name one tool of aeronautics and explain how it is used to test an aircraft design.

There are four possible answers:

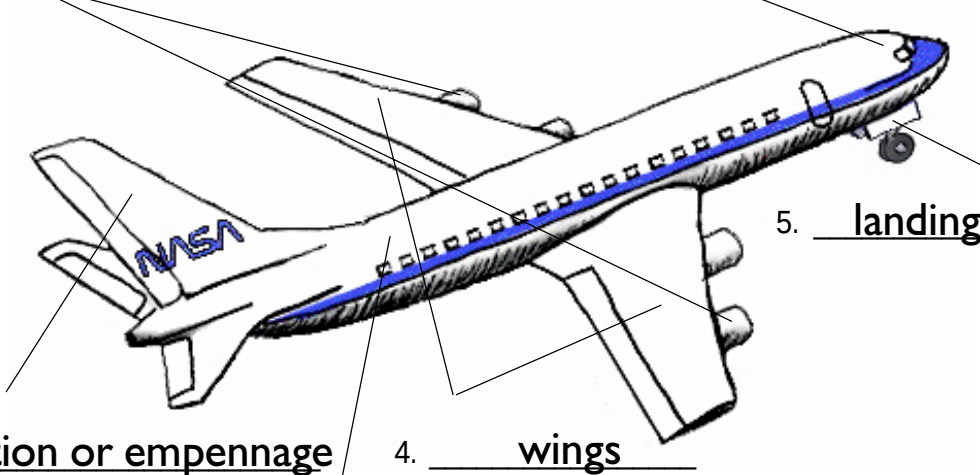
- *Computational Fluid Dynamics: Using computers to solve complex air flow equations.*
- *Wind Tunnel: a way to verify the CFD results by flying a model inside a tube or tunnel*
- *Flight Simulation: a mathematical model of a research airplane is programmed into a computer which manipulates a simulator cockpit .This tool is used to examine the handling qualities of the airplane, as well as the cockpit control's configuration.*
- *Flight Test: Instruments are placed on the airplane and a trained test pilot takes the airplane through a list of maneuvers. Based on the results, the airplane might be tested further.*

8. Explain how computers are used in aeronautical research.

Answers will vary, but below are listed some possibilities:

- *to solve complex mathematical equations*
- *to run software program that control simulators*
- *to collect data*

9. Label the parts of the airplane in the diagram below.



1. engines
2. tail section or empennage
3. fuselage
4. wings
5. landing gear
6. cockpit

10. Explain the differences between a straight wing airplane design and a delta wing airplane design.

Straight wing:

- *the leading edge is straight*
- *it is designed for use more so by subsonic aircraft*
- *is more fuel efficient at slower speeds*

Delta Wing:

- *the leading edge is slanted back towards the tail of the airplane*
- *it is designed for use more so by supersonic aircraft*
- *is more fuel efficient at faster speeds*

Exploring Aeronautics
Post-Test

Directions: This test will show what you have learned about aeronautics. It will be used to compare what you have learned about aeronautics to what you knew about aeronautics before the unit began. Do your best to answer each question below.

1. Name the four forces that act on an airplane.

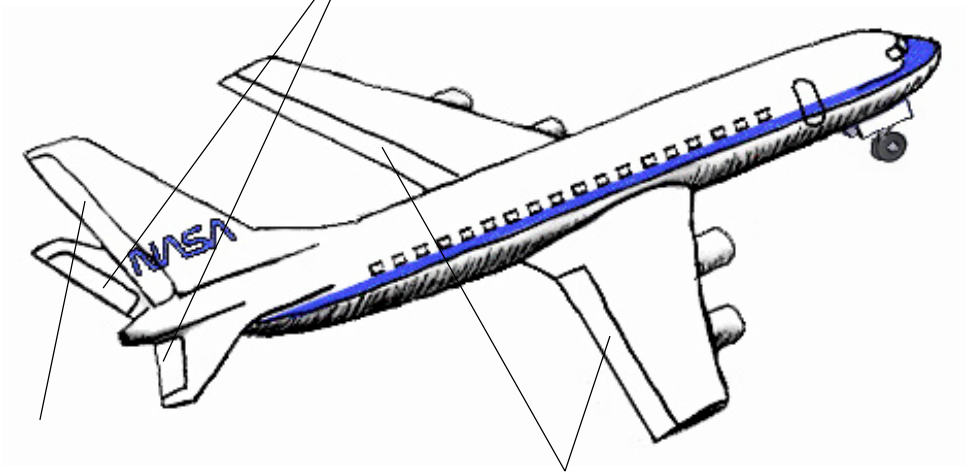
2. In your own words define aeronautics.

3. List the steps you would take to find the answer to a question or to solve a problem.

4. Name one important aeronautical event in history that improved the science of aeronautics. Explain how it improved aeronautics.

5. In the box below, draw a diagram that shows how a wing generates lift. Include these labels on your diagram: airfoil, airflow, high pressure, low pressure, lift.

6. On the diagram below, label each control surface and then tell what motion it affects.



1. _____ motion:_____

2. _____
motion:_____

3. _____
motion:_____

7. Name one tool of aeronautics and explain how it is used to test an aircraft design.

8. Explain how computers are used in aeronautical research.

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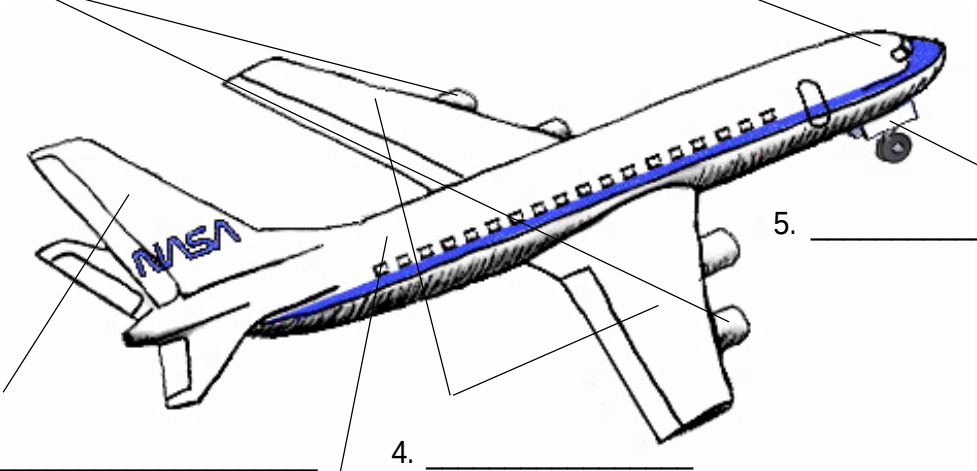

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Exploring Aeronautics
Post-Test
Answer Key

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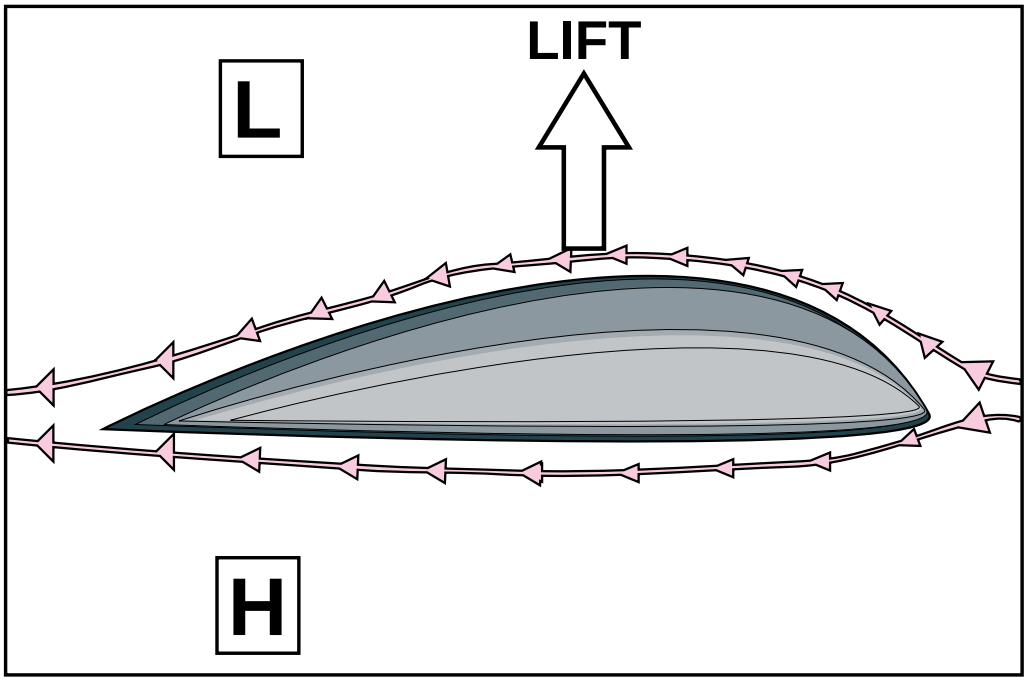

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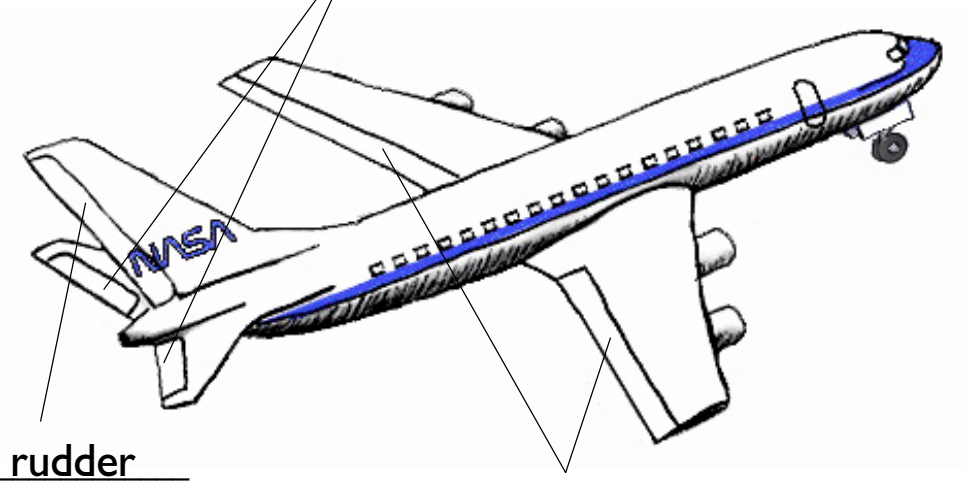

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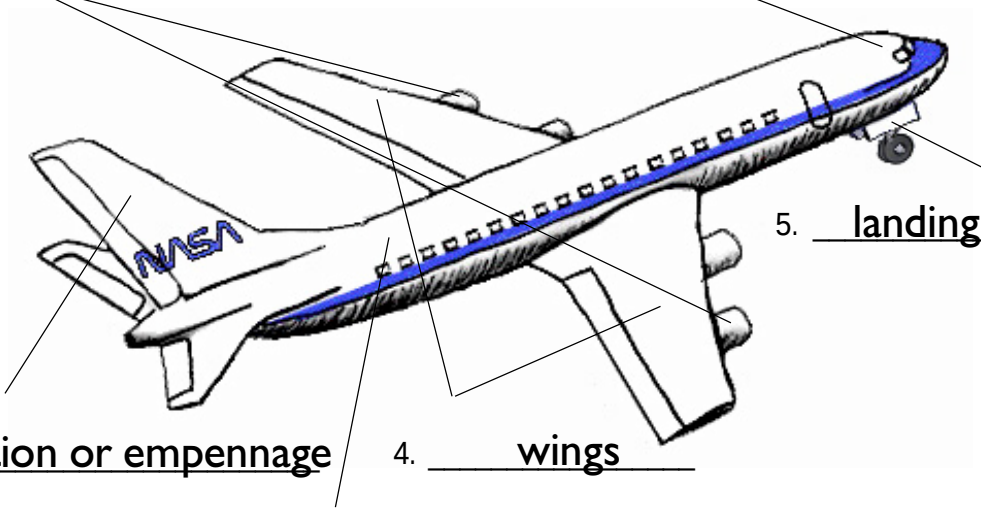

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Delta Wing

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Embedded Assessments

Embedded Assessments are activities that are integrated into the unit day-by-day. They actually appear to be part of the unit.

Independent Experiments

When the students are comfortable with the Scientific Method, select two experiments for evaluation - one midway through the unit and the other at the end. See the following Experiment Rubric for scoring.

The Experiment Logs for this unit are formatted as shown below.

Experiment Logs

Experiment log

NAME _____
DATE _____

EXPERIMENT:

Steps	Data
1. State the problem **QUESTION** (What do I want to know?)	
2. Form your hypothesis **ANSWER** (What do I think is going to happen?)	
3. Create an experiment **MATERIALS AND PROCEDURES** (What steps will I take to do this experiment? What things will I need?)	

Experiment log

NAME _____
DATE _____

EXPERIMENT:

Steps	Data
4. Do the experiment and record the data (What information did I gather during this experiment?)	
5. Organize and analyze your results (Make a graph, chart, picture or diagram)	
6. Draw your conclusion (What do my results mean? Was my hypothesis right or wrong? Can I explain why?)	

Experiment Rubric

	(4) Pilot	(3) Co-Pilot	(2) Student Pilot	(1) Passenger
Accurately explains aeronautical idea behind experiment.	Gives an accurate explanation of the phenomenon, using appropriate aeronautical terms which reflect a thorough understanding.	Gives an accurate explanation of the phenomenon, using appropriate aeronautical terms which reflect a basic understanding.	Gives an explanation of the phenomenon, but misapplies or omits some aeronautical terms and principles that are important for understanding.	Gives an explanation of the phenomenon, but omits key aeronautical terms and principles or does not use the appropriate terms and principles.
Makes a logical prediction based on aeronautical principles.	Makes a prediction that reflects insight into the nature of the phenomenon that is entirely appropriate to the aeronautical principles being applied.	Makes a prediction that follows from appropriately applied aeronautical principles which can be verified.	Makes a prediction that indicates misunderstandings in application of the aeronautical principles used to explain the phenomenon. The prediction is difficult to verify.	Makes a prediction which cannot be verified due to a lack of understanding in applying the aeronautical principles involved.
Sets up and carries out experiment.	Sets up and carries out an experiment that is a complete and valid test of the prediction. Notes pertinent observations and collects relevant data.	Sets up and carries out an experiment that is a fair test of the prediction. Notes most observations and collects most data.	Attempts to set up and carry out an experiment that loosely tests the prediction. Makes errors during data collection and makes limited observations in an indiscriminate way.	Attempts to set up and carry out an experiment that vaguely tests the prediction. Collects very little data and makes few observations.
Evaluates the conclusion in terms of aeronautical principles.	Gives a complete and accurate explanation of outcome using appropriate aeronautical principles. Gives insight into aeronautical application of the results.	Gives a complete explanation of the outcome using some aeronautical principles with no important errors. Presents the conclusion using relevant aeronautical concepts.	Gives a general explanation of the outcome, but omits one or two important aspects. Does not effectively relate the outcome to any aeronautical principles.	Gives an inaccurate explanation of how the outcome relates to the prediction and aeronautical principles.

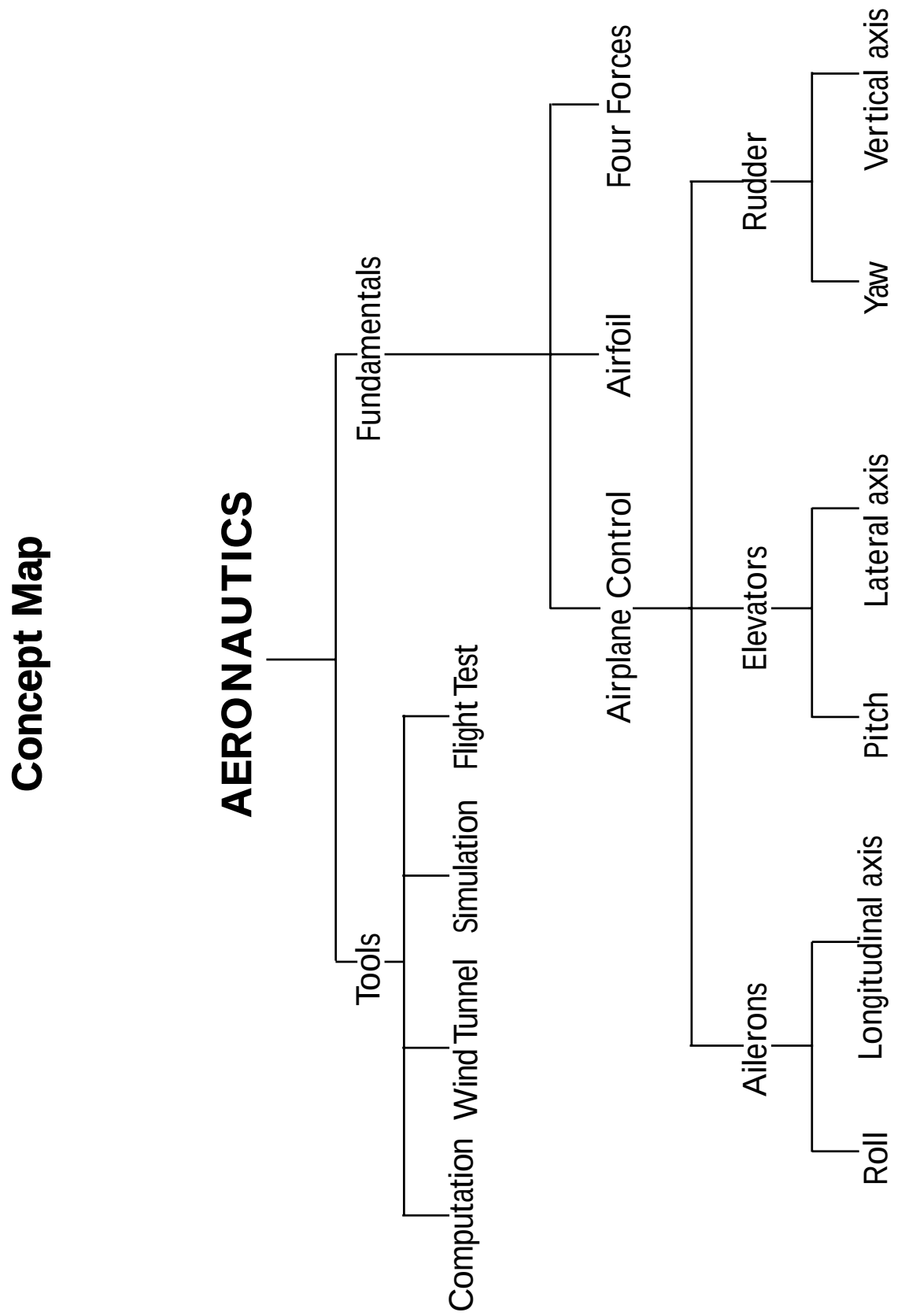
Concept Maps

At various times during the course of this unit, give students an aeronautical concept for them to map. Make sure that the concepts have been introduced, covered and reinforced before engaging in a concept mapping activity.

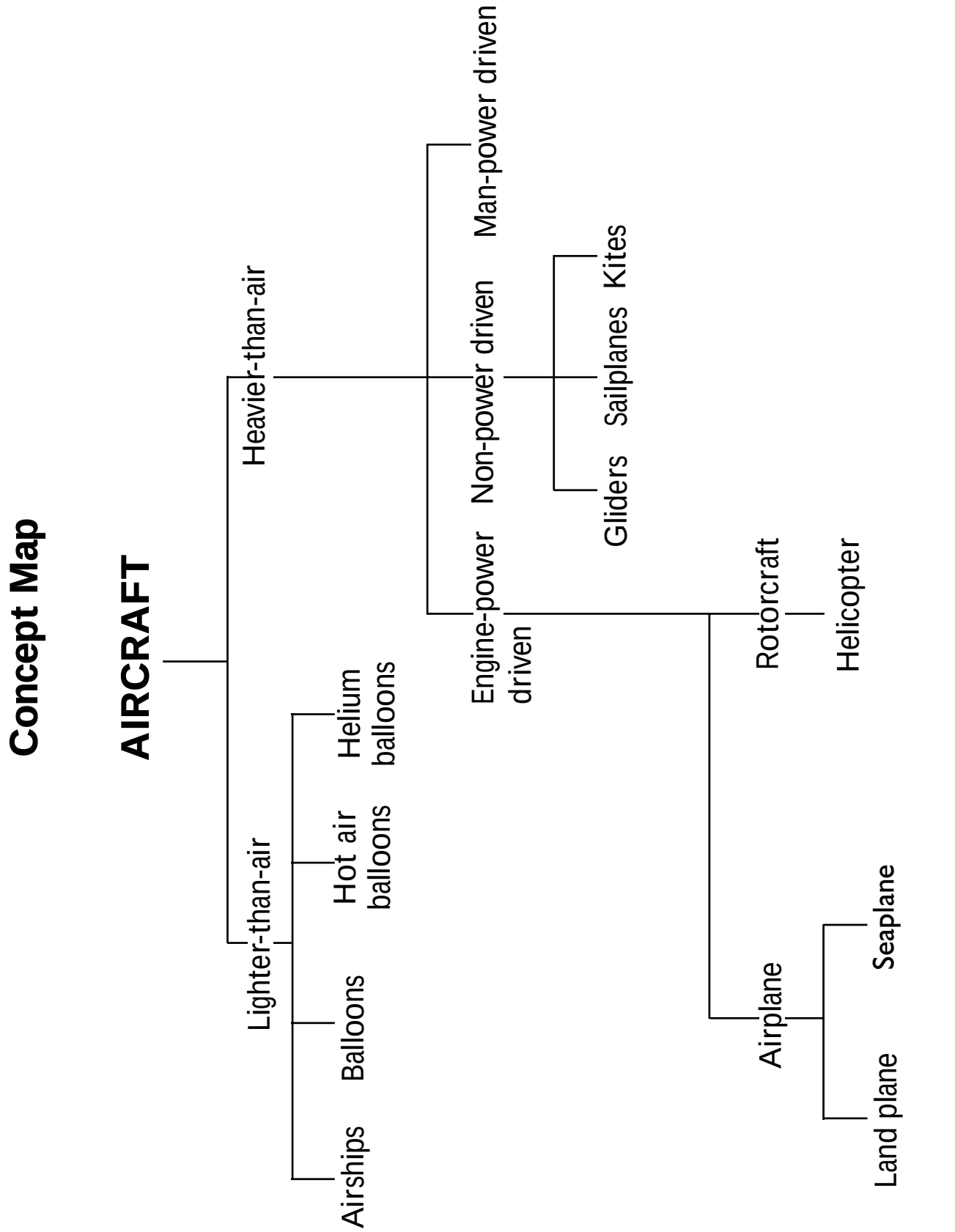
Possible concept mapping topics are listed below, with examples found on the following pages.

1. Aeronautics
2. Aircraft
3. Fundamentals of Aeronautics or How An Airplane Flies
4. Tools of Aeronautics
5. Four Forces

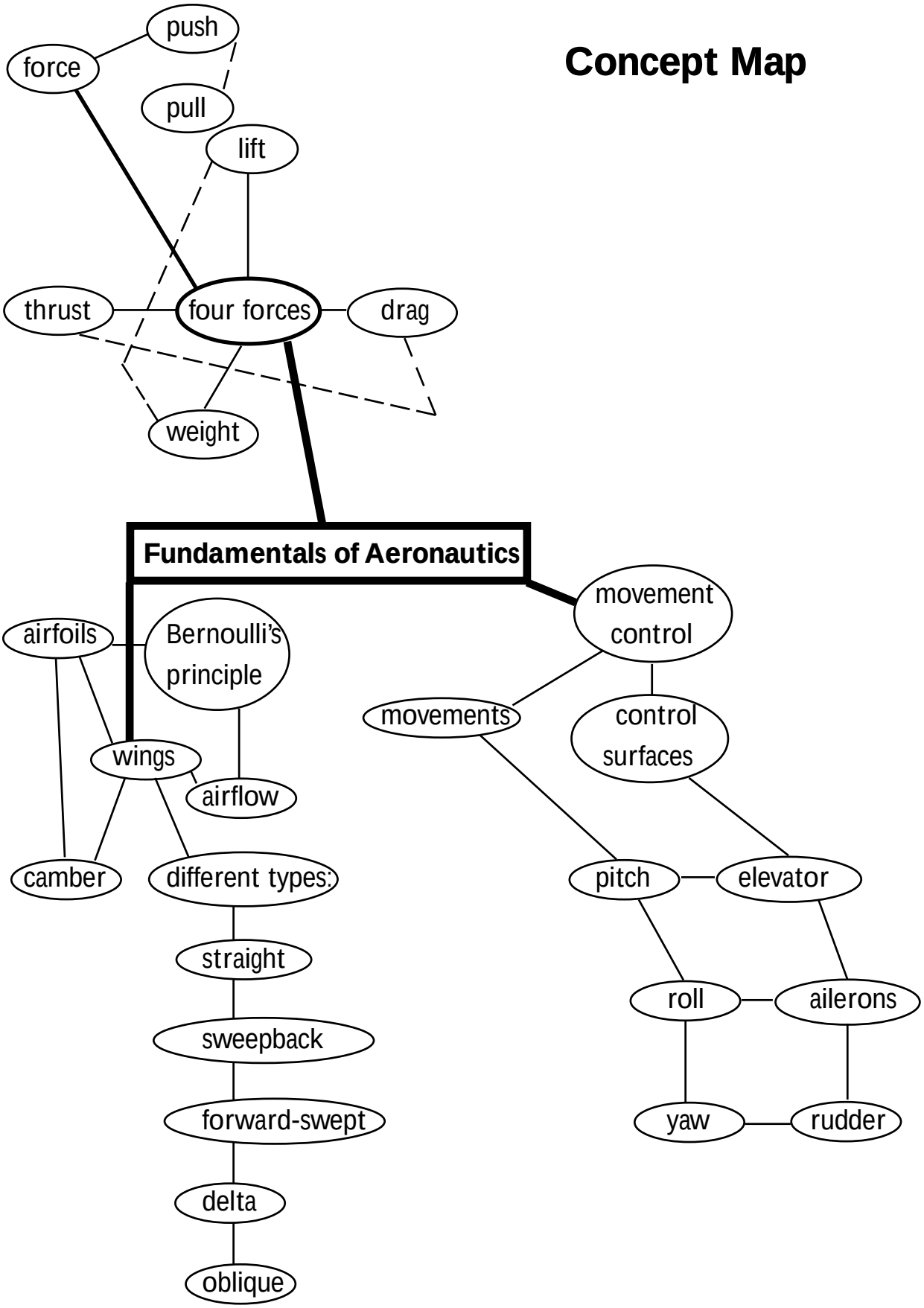
Concept Map


AERONAUTICS
Fundamentals
Tools
Computation
Wind Tunnel
Simulation
Flight Test
Airplane Control
Four Forces
Airfoil
Ailerons
Roll
Longitudinal axis
Elevators
Pitch
Lateral axis
Rudder
Yaw
Vertical axis

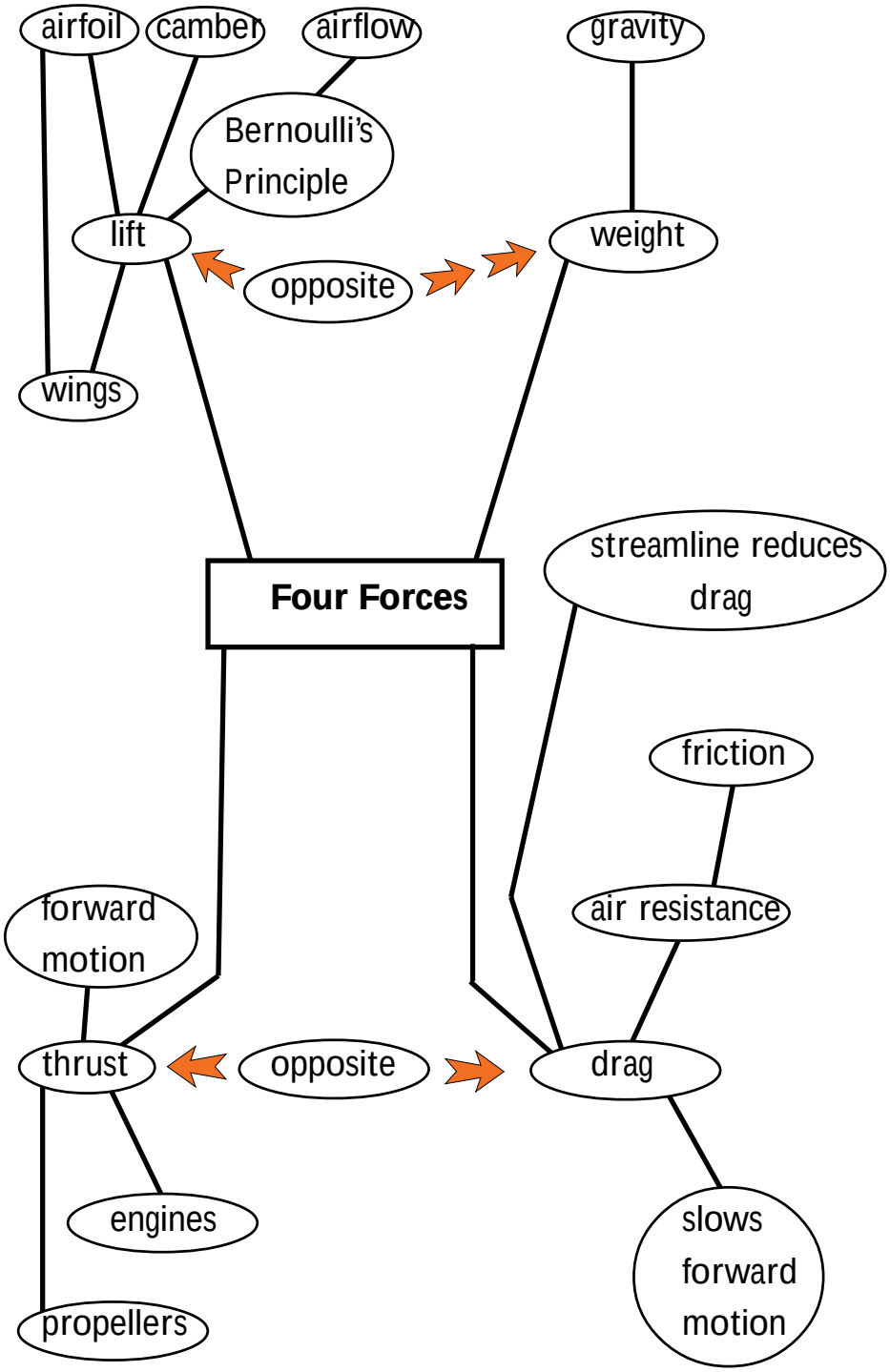
Concept Map

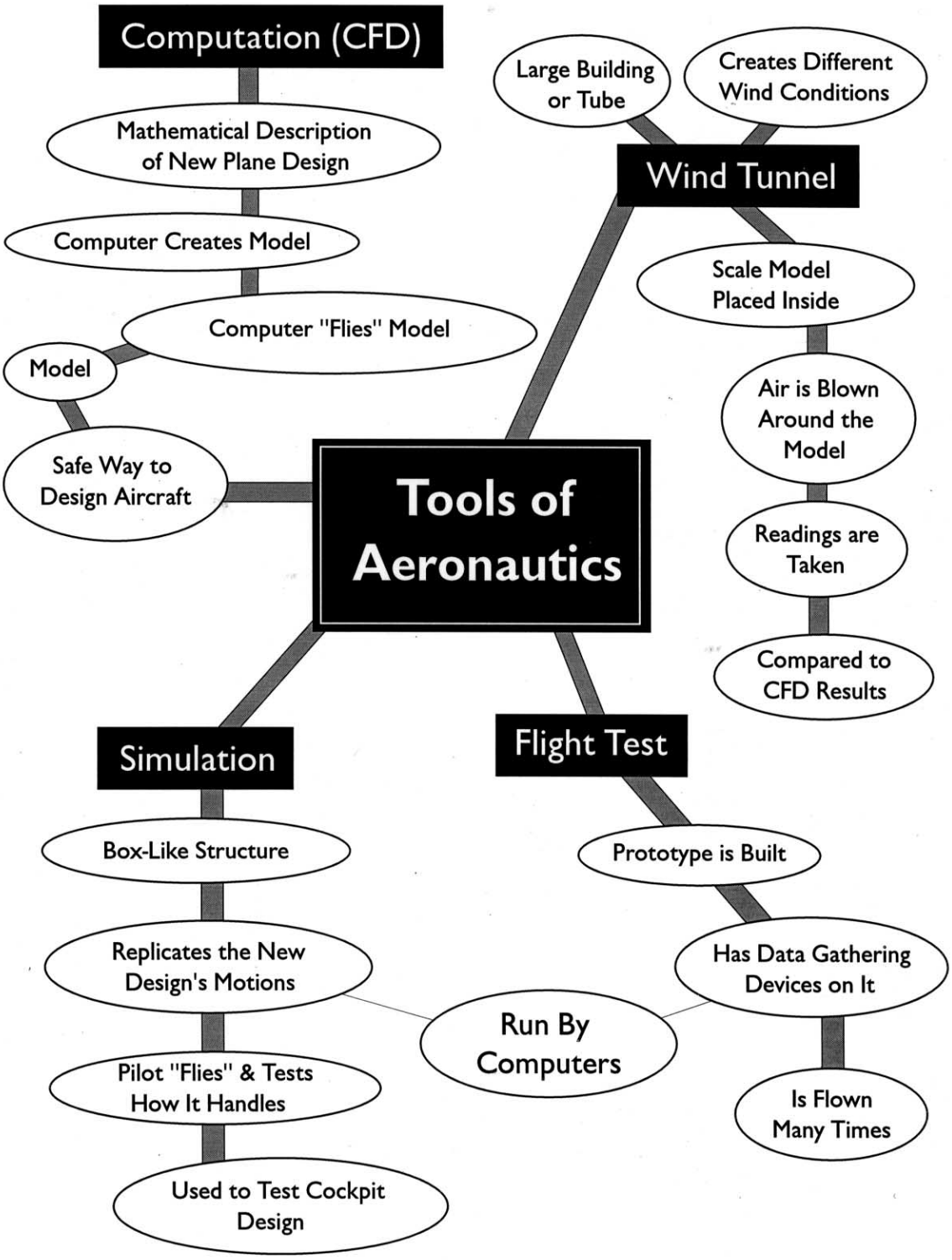

AIRCRAFT
Heavier-than-air
Lighter-than-air
Airships
Balloons
Hot air balloons
Helium balloons
Engine-power driven
Non-power driven
Man-power driven
Gliders
Sailplanes
Kites
Rotorcraft
Helicopter
Airplane
Land plane
Seaplane

Concept Map


push
force
pull
lift
thrust
four forces
drag
weight
Fundamentals of Aeronautics
movement control
airfoils
Bernoulli's principle
movements
control surfaces
wings
airflow
camber
different types:
pitch
elevator
straight
roll
ailerons
sweepback
yaw
rudder
forward-swept
delta
oblique

Concept Map


airfoil
camber
airflow
gravity
Bernoulli's Principle
lift
opposite
weight
wings
Four Forces
streamline reduces drag
friction
forward motion
air resistance
thrust
opposite
drag
engines
slows forward motion
propellers


Tools of Aeronautics
Computation (CFD)
Mathematical Description of New Plane Design
Computer Creates Model
Computer "Flies" Model
Model
Safe Way to Design Aircraft
Wind Tunnel
Large Building or Tube
Creates Different Wind Conditions
Scale Model Placed Inside
Air is Blown Around the Model
Readings are Taken
Compared to CFD Results
Simulation
Box-Like Structure
Replicates the New Design's Motions
Pilot "Flies" & Tests How It Handles
Used to Test Cockpit Design
Flight Test
Prototype is Built
Has Data Gathering Devices on It
Is Flown Many Times
Run By Computers

Pictorial and Drawing Assessments

Included in this section are two different types of assessment.

1. Pictorial: Students are given a picture and are required to answer questions concerning what they observe.

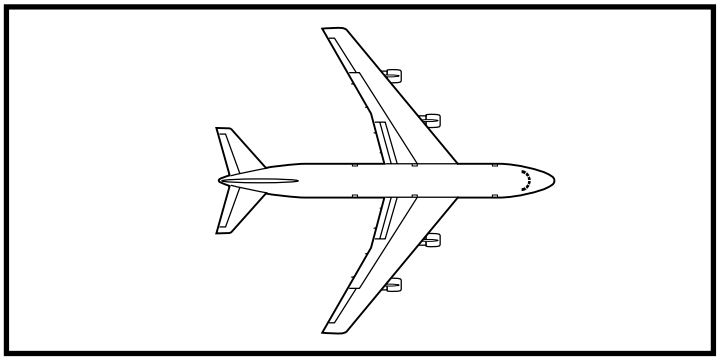
    - Will This Airplane Fly?
    - Changing the Flight Path of An Airplane #1
    - Changing the Flight Path of An Airplane #2
    - Prediction

2. Drawing: Students are given a question and are required to draw or diagram their answer with labels.

    - How a Wing Generates Lift

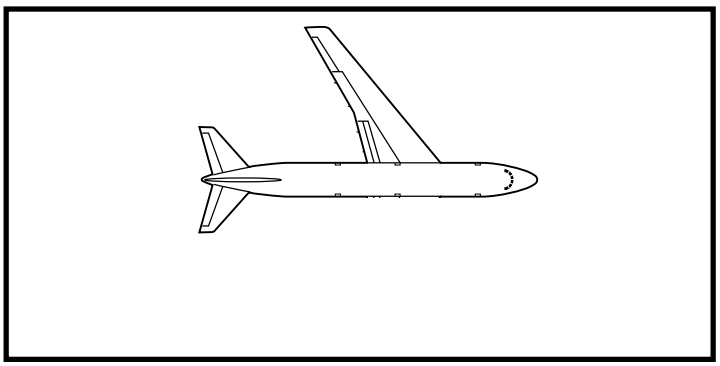
Will This Airplane Fly?

Directions: Below each airplane picture circle "yes" if the airplane will create enough lift to fly or "no" if it will not create enough lift to fly. Then, explain why. Be sure to use aeronautical facts to support your answer.



1. yes no

Reason: _____
_____
_____
_____

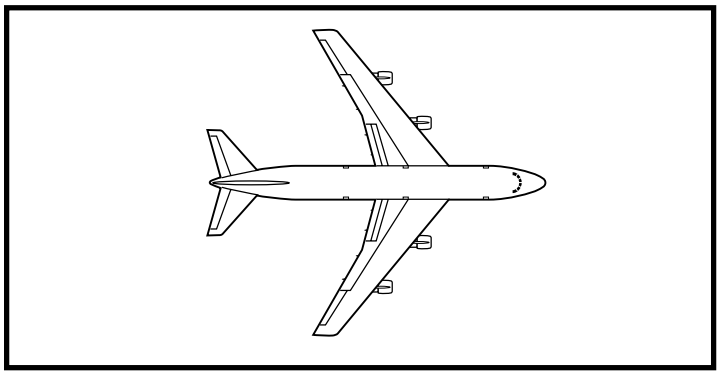


2. yes no

Reason: _____
_____
_____
_____

Will This Airplane Fly? - Key

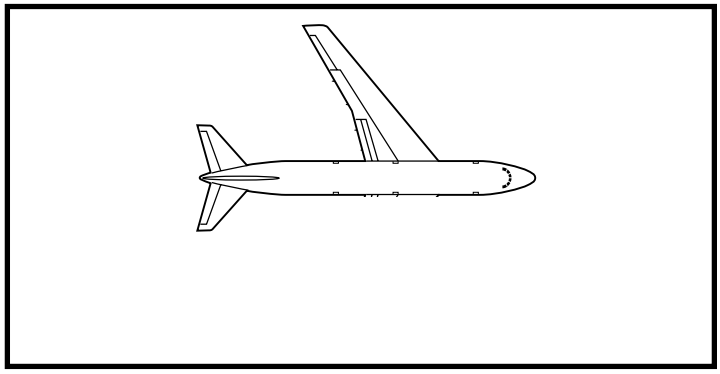
Directions: Below each airplane picture circle "yes" if the airplane will create enough lift to fly or "no" if it will not create enough lift to fly. Then explain why. Be sure to use aeronautical facts to support your answer.



1. (yes) no

Reason: *Yes, it has wings for lift and an engine for thrust. The engines will provide the speed and the wings will create the lift.*

.



2. yes (no)

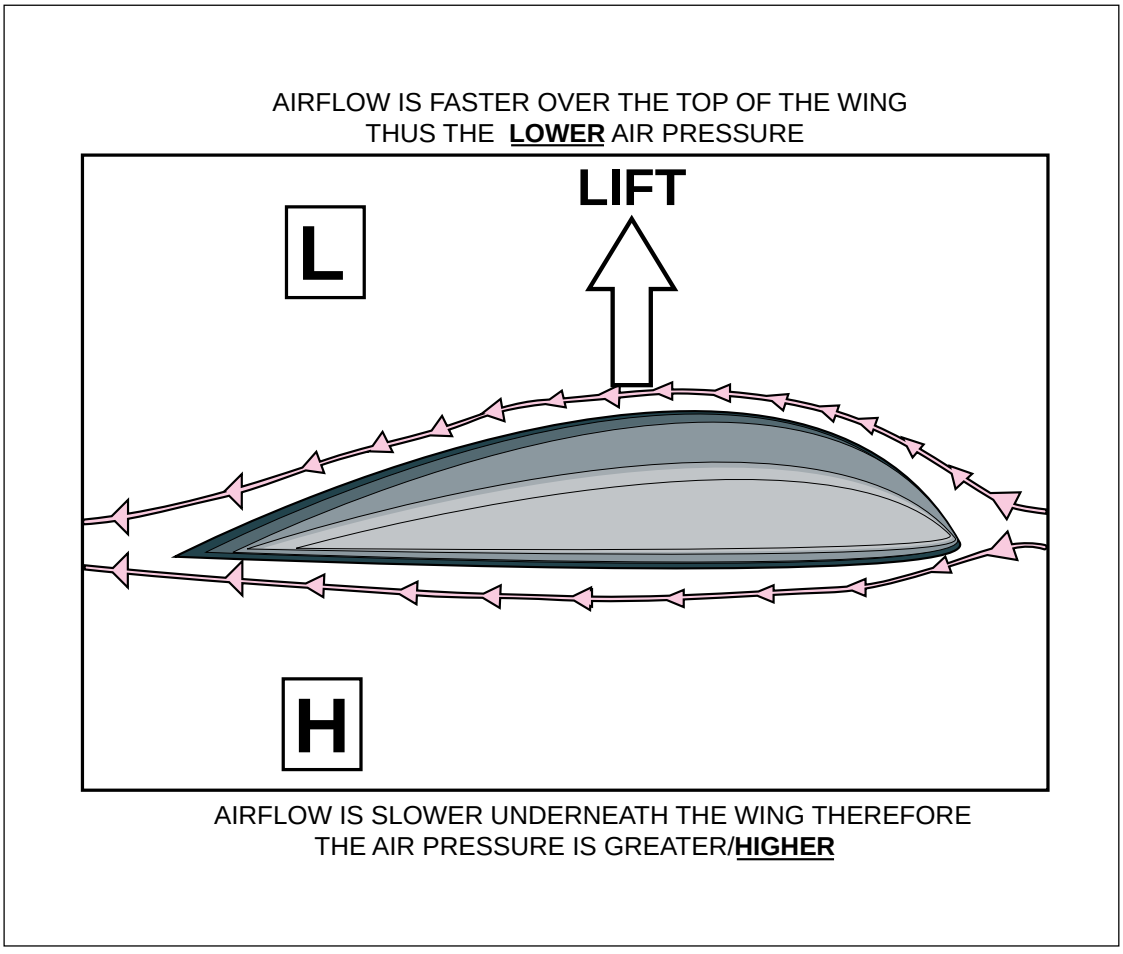
Reason: *It does not have an engine for thrust and it has only one wing for lift. One wing won't generate enough lift.*

How a Wing Generates Lift

Directions: Draw a diagram that shows clearly how a wing generates lift. Make sure you include labels that show the wing, airflow, airflow speed, lift, high pressure area and low pressure area.

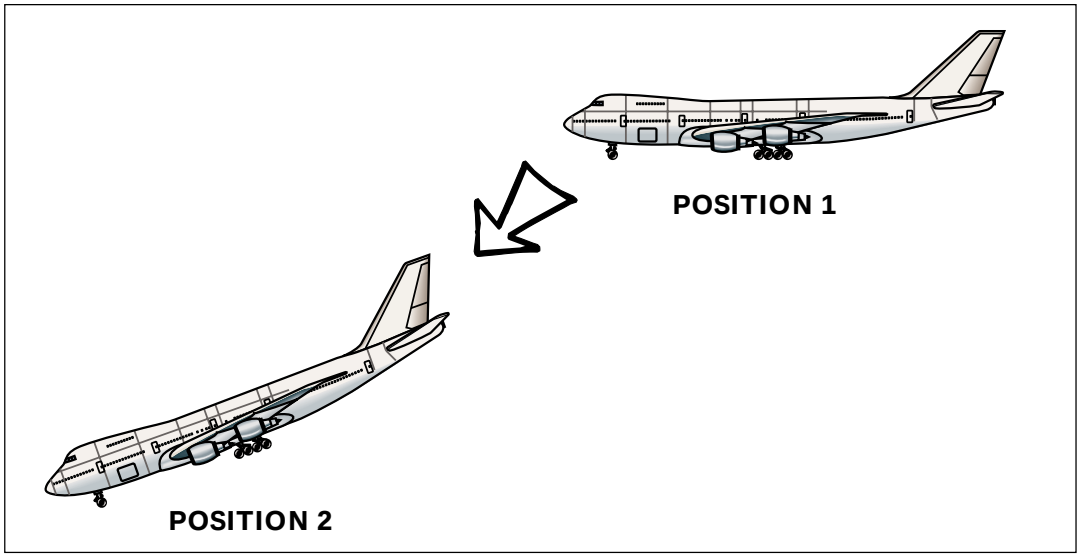
How a Wing Generates Lift - Key

Directions: Draw a diagram that shows clearly how a wing creates lift. Make sure you include labels that show the wing, airflow, airflow speed, lift, high pressure area and low pressure area.



Changing the Flight Path of an Airplane #1

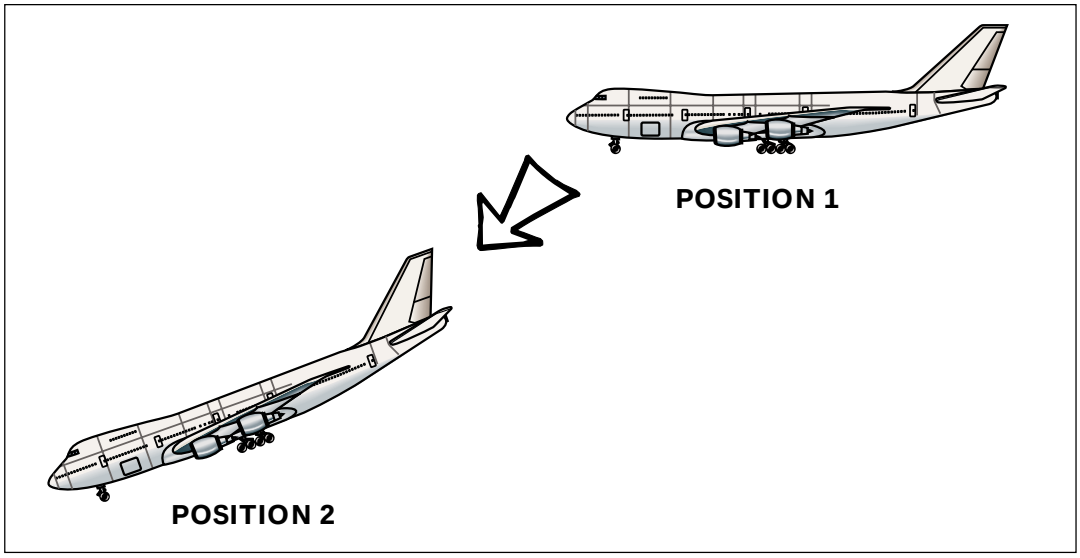
Directions: What could the pilot of the airplane in the picture below do to make the airplane move from position 1 to position 2? Be very specific in your explanation and use aeronautical vocabulary.



Explanation:

Changing the Flight Path of an Airplane #1 – Key

Directions: What could the pilot of the airplane in the picture below do to make the airplane move from position 1 to position 2? Be very specific in your explanation and use aeronautical vocabulary.

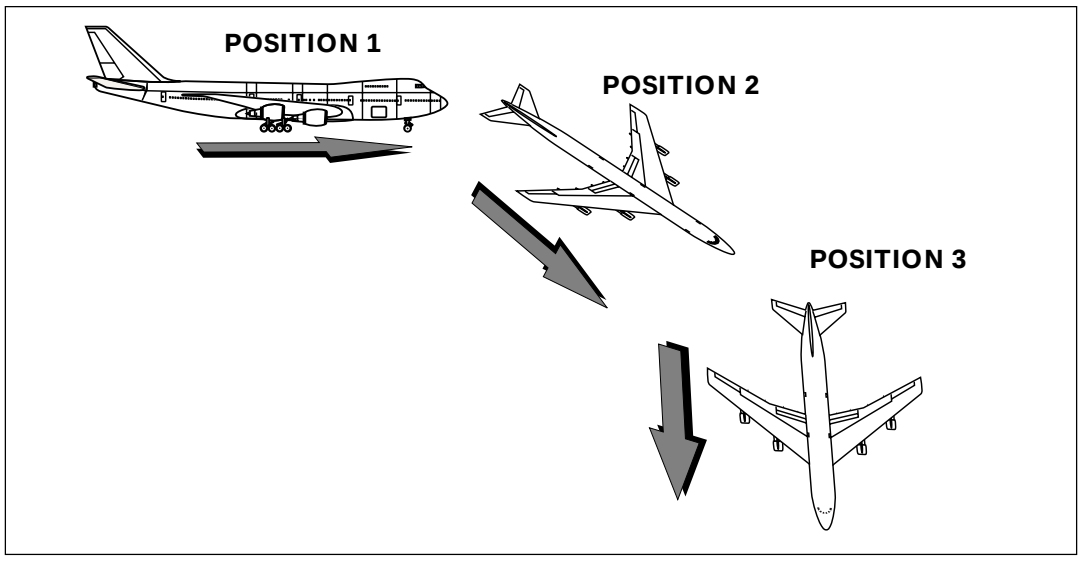


Explanation:

The pilot could slow down (decelerate) the speed of the airplane by decreasing thrust. Then, adjust the elevator into the down position which would cause the nose of the airplane to pitch down.

Changing the Flight Path of an Airplane #2

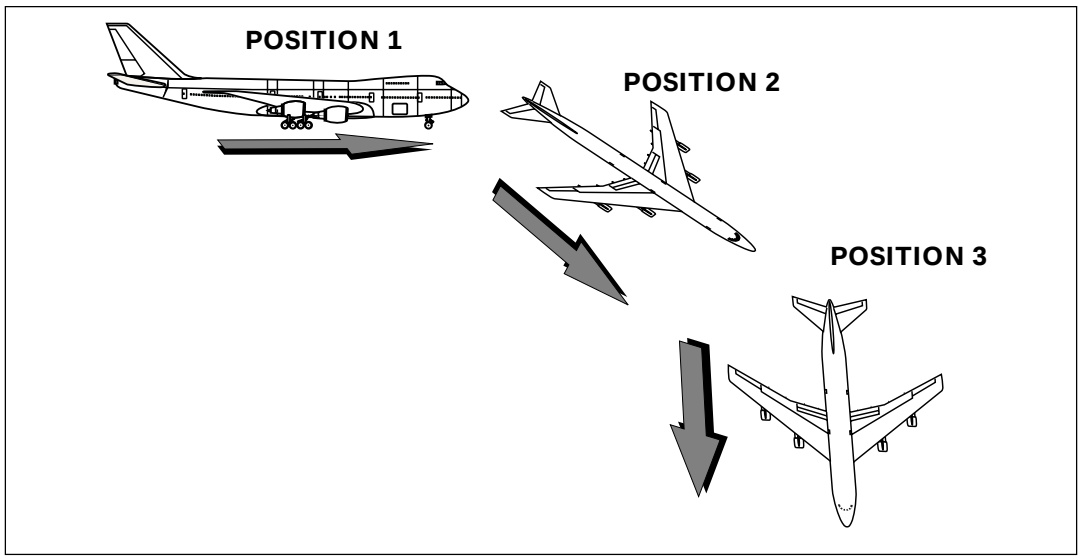
Directions: What could the pilot of the airplane in the picture below do to make the airplane move from position 1 to position 2? Be very specific in your explanation and use aeronautical vocabulary.



Explanation:

Changing the Flight Path of an Airplane #2 – Key

Directions: What could the pilot of the airplane in the picture below do to make the airplane move from position 1 to position 2? Be very specific in your explanation and use aeronautical vocabulary.



Explanation:

Move the elevator into the down position so that the nose of the airplane pitches down. Move the right aileron into the up position, the left aileron into the down position. This will cause the airplane to roll right. Move the rudder to the right so the airplane yaws to the right.

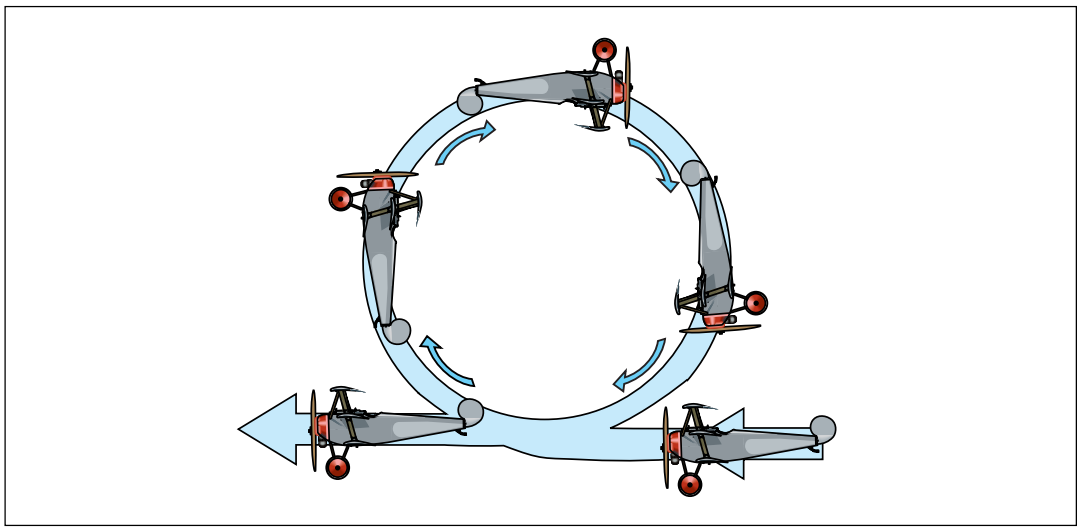
Prediction

Directions: This airplane is flying straight and level. Predict the airplane's flight pattern when the pilot accelerates and moves the elevators into the up position. Complete the flight path by drawing it into the box. Then, explain why the airplane will react in that way.

Explanation for Flight Path

Prediction - Key

Directions: This airplane is flying in a steady, level flight pattern. Predict the airplane's flight pattern when the pilot accelerates and moves the elevators into the up position. Complete the flight path by drawing it into the box. Then, explain why the airplane will react in that way.



Explanation for Flight Path

The elevators in the up position cause the airplane's nose to pitch upward. This, combined with the increased thrust, will cause the airplane to fly a loop.

Performance Task

Performance Tasks can be fun for students doing a hands-on activity during which they must use scientific processes such as prediction, observation, classification, measurement, etc. The Performance Task on the following pages can be used also as an embedded activity or experiment in association with lessons on control surfaces.

Control Surfaces

Student Instructions

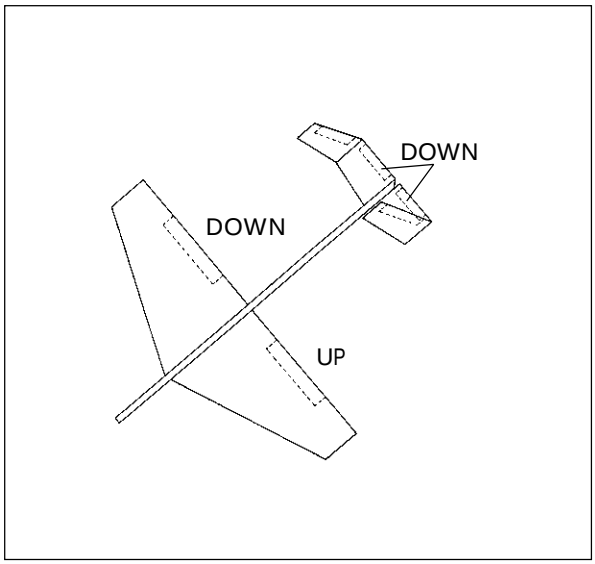
Directions: Using a piece of paper of your choice, create a glider with control surfaces that work. Then, adjust the control surfaces to perform the two stunts indicated on your worksheet.

For each maneuver, draw a diagram of your paper airplane in the box on the left and color the control surfaces you used to perform the maneuver. Label the names of each control surface. Then tell the position each one was in (up, down, left, right, etc.)

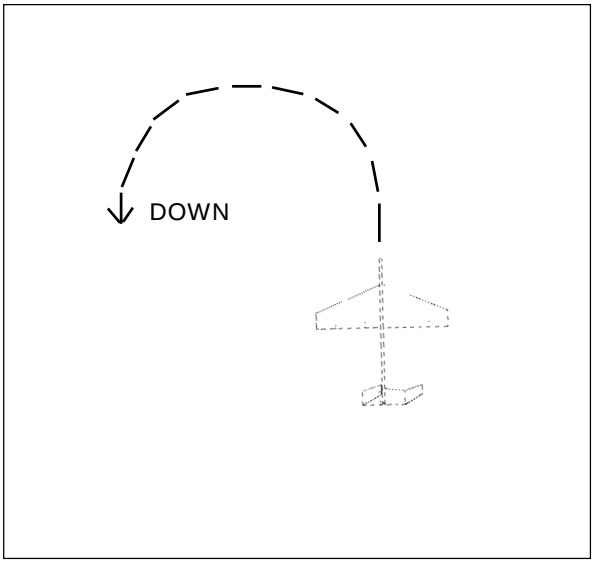
In the box on the right, draw its flight path. Use arrows to show the flight of your paper airplane.

Below is an example of a roll to the left that pitches downward.

Airplane Diagram with Control Surfaces



Flight Path



Control Surfaces

Student Worksheet

Maneuver 1: a loop-the-loop

Airplane Diagram with Control Surfaces

Flight Path

Maneuver 2: a roll to the left that pitches upward

Airplane Diagram with Control Surfaces

Flight Path

Control Surfaces

Student Worksheet

Maneuver 3: a roll to the right that pitches upward

Airplane Diagram with Control Surfaces

Flight Path

Maneuver 4: a series of barrel rolls

Airplane Diagram with Control Surfaces

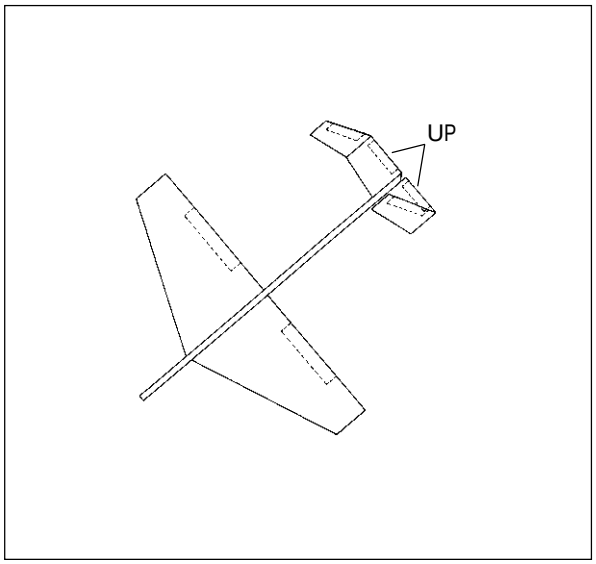
Flight Path

Control Surfaces

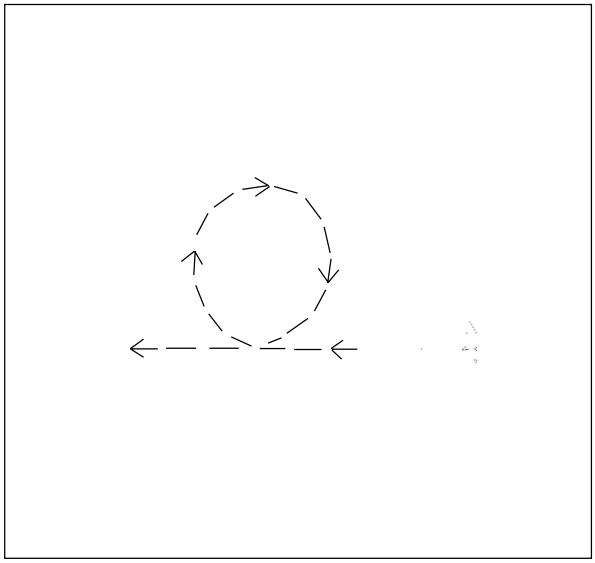
Student Worksheet – Key

Maneuver 1: a loop-the-loop

Airplane Diagram with Control Surfaces

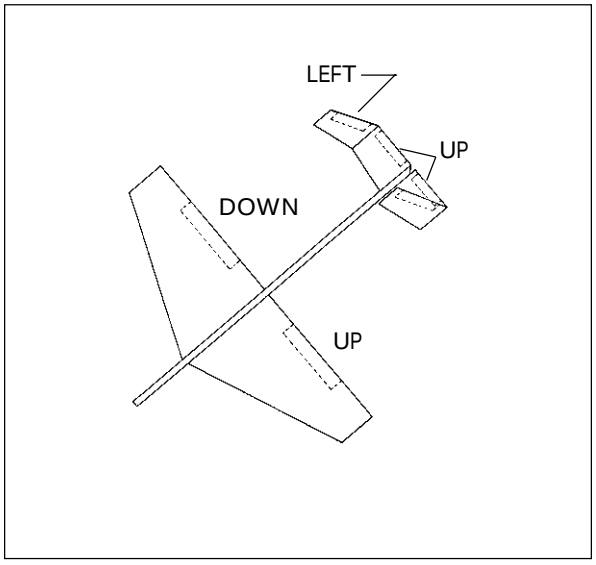


Flight Path

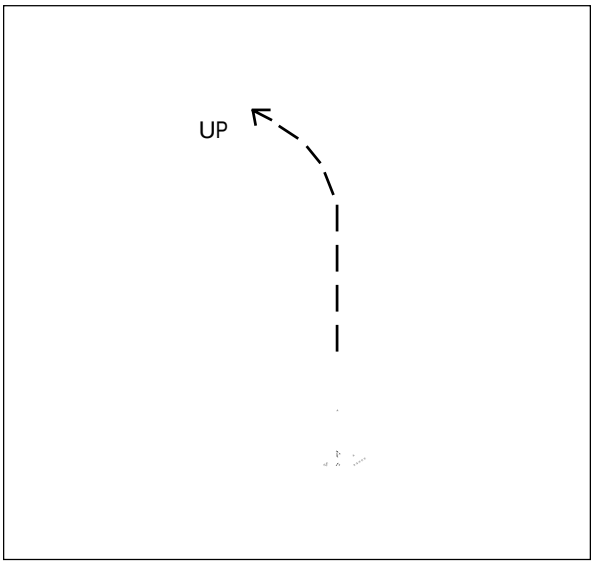


Maneuver 2: a roll to the left that pitches upward

Airplane Diagram with Control Surfaces



Flight Path

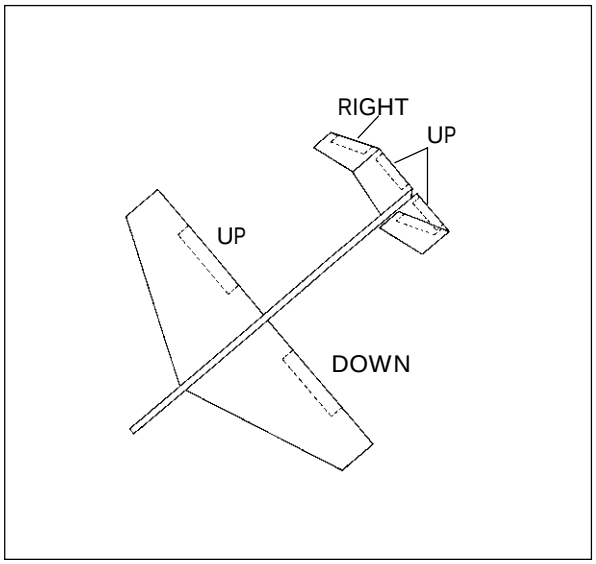


Control Surfaces

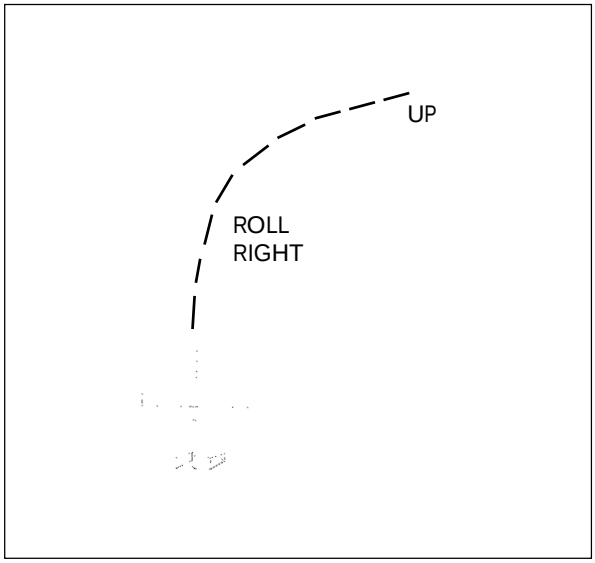
Student Worksheet – Key

Maneuver 3: a roll to the right that pitches upward

Airplane Diagram with Control Surfaces

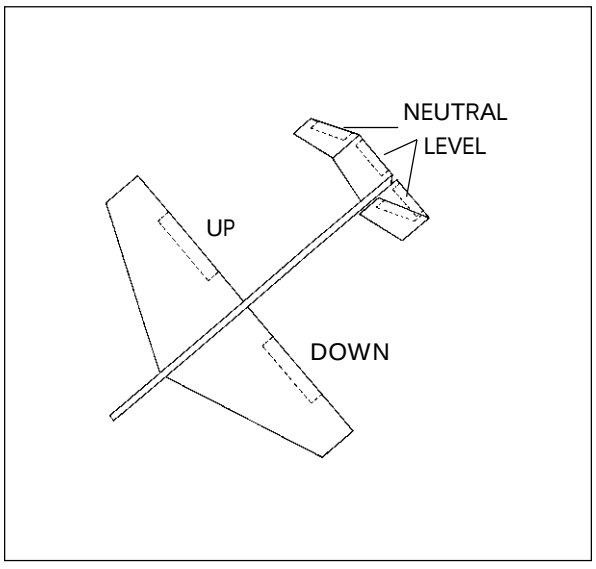


Flight Path

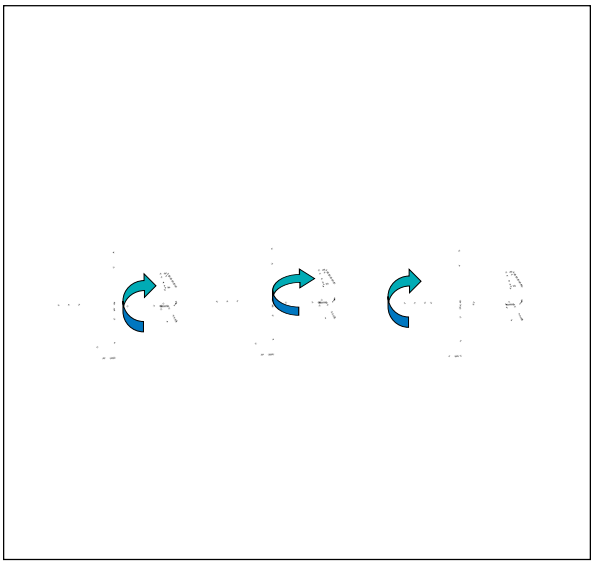


Maneuver 4: a series of barrel rolls

Airplane Diagram with Control Surfaces



Flight Path



Portfolio Assessment

A portfolio is a system of assessment that collects samples of student work which have been completed over a specific period of time. These samples can be used as evidence of individual student progress. Portfolios are truly useful when the purpose of learning is defined in advance and the criteria for assessing learning is clearly identified. This particular portfolio design is a "Showcase Portfolio". A Showcase Portfolio is mainly used to "show off" the individual student's work as a culmination of the learning segment. This could be used in conjunction with the culminating Air Show event or incorporated into your own portfolio program.

For this Showcase Portfolio we have identified the following nine components:

- concept map
- labeled diagram
- creative writing entry
- one set of notes
- science experiment
- math connection activity
- comparison chart
- art/ music/ dramatic work
- student choice

For each component we have included a personal reflection sheet which can be completed by the student while compiling work for his/her portfolio.

Also, we have included an "Aeronautics rubric" as well as a teacher introductory cover sheet ("Aeronautics Portfolio") for the portfolio. The rubric will fit most of the student projects and activities described in this unit. The cover sheet will serve to introduce the skills, concepts and processes inherent in the Science of Flight Unit as well as the goals of the portfolio process. Feel free to adapt either of these to better accommodate your own assessment procedures.

Aeronautics Rubric

	(5) Captain	(4) Assn't. Cap't.	(3) Solo Pilot	(2) Student Pilot	(1) Passenger
Concept	Demonstrates a thorough understanding of aeronautical concepts and facts at the lower taxonomy levels and uses them appropriately.	Demonstrates a strong understanding of aeronautical concepts and facts at the lower taxonomy levels and uses them appropriately most of the time.	Demonstrates a basic understanding of most aeronautical concepts and facts at the lower taxonomy levels and uses them appropriately only some of the time.	Beginning to demonstrate a basic understanding of some aeronautical concepts and facts at the lower taxonomy levels and uses them appropriately only on occasion.	Demonstrates little to no understanding of basic aeronautical concepts and facts at the lower taxonomy levels and rarely uses them appropriately.
Processes	Thoroughly uses scientific processes correctly in the appropriate situation.	Uses scientific processes correctly most of the time in appropriate situations.	Uses scientific processes correctly some of the time in appropriate situations.	Attempts to use scientific processes unsuccessfully in random situations.	Fails to use scientific processes appropriately or successfully.
Cognitive	Interprets the information gathered in accurate and insightful ways, and synthesizes information in a highly creative and unique way.	Accurately interprets information gathered w/ some insight and synthesizes information in some unique ways.	Accurately interprets information gathered and synthesizes information concisely.	Makes significant errors when interpreting the information gathered and synthesizes information w/ some imprecision and awkwardness.	Grossly misinterprets information gathered and fails to synthesize.
Constructing	Accurately identifies a claim and provides relevant evidence that supports the claim. Considers any missing information and evaluates its effectiveness.	Accurately identifies a claim and provides relevant evidence w/out major errors.	Accurately identifies a claim and provides some relevant evidence to support it w/some suitable details.	Identifies a claim, but provides marginal evidence that does not address all major aspects of the claim.	Fails to correctly identify a claim as such and does not provide convincing evidence.
Communication	Clearly and effectively communicates main ideas w/supporting details that are appropriate, rich and powerful.	Clearly and somewhat effectively communicates main ideas w/plenty of appropriate details.	Clearly communicates main ideas with some suitable supporting details.	Attempts to communicate important information, but communication has an unclear main idea w/minor details.	Information is communicated in isolated bits and expressed in a random fashion.

Aeronautics Portfolio

For our science class, we will be keeping a portfolio for our integrated unit on Aeronautics. Just as professionals in many different fields maintain a collection of their best work in a portfolio, your child will showcase his/her best work in their Aeronautics Portfolio. These samples will not only be science oriented, but will also be drawn from the content areas of language arts, social studies and mathematics. The portfolio will supplement the assessment process and will provide concrete examples of your child's work during the unit. It will also provide a means for your child to reflect upon the work he/she does and assess his/her own progress. It is our hope that through this process we will capture your child's learning experiences and growth in a concrete manner and more clearly demonstrate the progress your child has made.

Student Reflection: Concept Map

Title of this Piece:

Description of this piece: Concept Map of _____

What is the goal of this type of assignment?

How many main ideas did you record on the piece?

Estimate how many details you averaged for each main idea on this piece.

Do you think your map has a lot of details and strong connections?
Tell why or why not.

What did you learn from this mapping assignment?

Was this type of assignment difficult or easy for you to do? Why do you think so?

Student Reflection: Labeled Diagram

Title of this Piece:

Description of this piece: Diagram of _____

What did you learn from working on this assignment?

What challenges or problems did you encounter while working on this assignment?

How does this assignment connect with other work in this unit?

If you did this assignment over, how would you do it?

What did you learn about yourself while working on this assignment?

Student Reflection: Creative Writing

Title of this Piece:

Description of this Piece:

How did your pre-write help you to create this piece?

Give one example of figurative language from this piece and tell why you used that type of figurative language.

What challenges or problems did you encounter when doing this assignment?

What could you do to make this piece of writing even better?

What did you learn from doing this assignment?

Student Reflection: Set of Notes

Title of this Piece:

Description of this Piece:

What is the goal of this type of assignment?

How important is it for you to learn how to take notes?

Is this type of assignment difficult for you or easy? Why?

What challenges or problems did you encounter when trying to take notes?

Give some ideas on how you will overcome the challenges found in learning to take notes.

Student Reflection: Science Experiment

Title of this Piece:

Description of this Piece:

Why did you select this particular experiment for your portfolio?

What is the best part of your work on this experiment?

Name your least favorite part of this experiment and tell why it was your least favorite.

How does this experiment connect to the rest of the unit on aeronautics?

What did you learn from doing this experiment?

Student Reflection: Math Connection Activity

Title of this Piece:

Description of this Piece:

What was the goal of this math activity?

How well did you accomplish this goal?

What did you learn from this activity?

How did this math activity connect to aeronautics?

What did you learn about yourself while working on this math activity?

Student Reflection: Comparison Chart

Title of this Piece:

Description of this Piece:

Why do you think it is important to learn to make comparisons?

List the criteria you used when telling in what ways the two items were different?

Why did you pick this particular comparison chart?

What did you learn from doing this type of assignment?

Student Reflection: Art/Music/Dramatic Piece

Title of this Piece:

Description of this Piece:

Why did you choose this particular creative piece?

What did you learn about yourself from working on this piece?

If you did this assignment over, how would you do it differently?

How does this connect to the unit on aeronautics?

Student Reflection: My Choice

Title of this Piece:

Description of this Piece:

Tell why you chose this piece for your own personal choice.

In doing this piece what was your goal?

How well did you accomplish your goal?

If you could do this assignment over, how would it be different?

What score do you think this work deserves? Why?

Self-Evaluation

Self-Evaluations provide the instructor with unique information about how each student perceives his or her work. Encouraging students to be reflective learners makes them more a part of their own learning process. It also gives the teacher an insight into attitudes the student has regarding science, learning and him/herself.

Included in this section are two self-evaluation forms. One is to be used specifically with the experiments which use the scientific method, while the other could be used after any aeronautics activity.

Experiment Assessment

Directions: Rate yourself and your work. On a scale of one (low) to ten (high), tell how well did you do on each part of this experiment.

Name of Experiment: _____

A) Hypothesis

Was not a good question because it did not deal with experiment.	My question did not completely cover the experiment.	I had a good question that covered what the experiment did.
1	5	10

B) Procedure

I left out a lot of steps.	I only included about half of the steps.	I included all the steps needed to do the experiment.
1	5	10

C) Materials

I left out most of what was needed.	I had included about half the things needed.	I had all the things needed to do the experiment.
1	5	10

D) Observation

I did not pay much attention the experiment and hardly wrote down anything.	I watched my experiment only half of the time and wrote down a few things.	I followed the exper- to iment closely and wrote everything I saw.
1	5	10

E) Making Connections

I did not understand what this had to do with flight.	I did understand how some parts explained flight.	I made more than one connection to flight.
1	5	10

Activity Assessment

Directions: Rate yourself and your work. On a scale of one (low) to ten (high), tell how well did you do on each part of this activity.

Name of Activity: _____

A) Following Directions

I skipped around a lot because I did not follow directions.

I closely followed the directions and did the steps in proper order.

1 5 10

B) Using Time Wisely

I wasted a lot of time.

I stayed on task the whole time.

1 5 10

C) Recording Observations/Information

I did not write much.

I wrote a lot and included everything I observed.

1 5 10

D) Working Well With Others

I got along only part of the time.

I got along most of the time.

1 5 10

E) Discussing Ideas/Results with Others

I did not add much to the discussion.

I contributed lots of ideas to the discussion.

1 5 10

F) List two things you learned about flight from this activity.

For those teachers who still have a place in their curriculum for traditional assessments, you will find included in this subsection the location for content quizzes and worksheets as well as a cumulative Aeronautics Final Test.

Section 2 of the Science of Flight unit is divided into six aeronautical content areas. Each content area contains a knowledge-level worksheet as well as a knowledge-level quiz. The worksheets could be utilized for review of the content covered in the student reading, with the quiz being used to assess the retention of the content covered at a later time. These forms of traditional assessment are not found in this section, but can be found on the pages given in the listing below.

This Traditional Assessment section includes a cumulative or final test. It is comprised of a standard mix of true/false, multiple choice and short answer questions.

Traditional Assessment

Aeronautics Final Test

Directions: Read each sentence below and tell whether the statement is true or false by placing a "T" or an "F" in the blank. Each question is worth ____ point(s).

_____ 1. The Wright Brothers made the first powered flight.

_____ 2. The Space Shuttle is actually like a large glider.

_____ 3. Chuck Yeager "broke the sound barrier" in 1947.

_____ 4. Gravity has no effect on whether an airplane flies or not.

_____ 5. The curved shape of a wing is not important to lift.

_____ 6. The pressure above the wing is lower than the pressure below the wing when an airplane is flying.

_____ 7. Aerodynamics is the study of gravity.

_____ 8. A force is only a push.

_____ 9. Subsonic speed means moving slower than the speed of sound.

_____ 10. Airfoils have camber.

Aeronautics Final Test (continued)

Directions: Choose the best answer for each question below and write the letter of that answer in the blank. Each question is worth ____ point(s).

_____ 11. What is the force opposite to lift?

A) weight B) thrust C) drag

_____ 12. What is the force opposite to thrust?

A) lift B) weight C) drag

_____ 13. Someone who operates an airship is called a(n) _____.

A) aeronaut B) cosmonaut C) astronaut

_____ 14. This scientist described what happened to water pressure when water flowed faster or slower.

A) Newton B) Bernoulli C) Lindbergh

_____ 15. Being able to move from one to five times the speed of sound is called ___.

A) subsonic B) transonic C) supersonic

_____ 16. The speed or quickness of motion is called ____.

A) stability B) velocity C) vertical

_____ 17. Another word for a wing's shape is ____.

A) rudder B) propeller C) airfoil

_____ 18. The measure of force that is created by the weight of air pressing down on the Earth's surface is called ____.

A) gravity B) air pressure C) aileron

Aeronautics Final Test (continued)

_____ 19. Which one of the answers below does not make thrust for an airplane?

A) jet engine B) propeller C) elevator

_____ 20. Which airplane listed below has two sets of wings?

A) monoplane B) biplane C) airship

Directions: Answer each question completely. Each question is worth _____ points.

_____21. List the 6 steps used in the Scientific Method.

_____22. Explain how an airplane generates lift.

Aeronautics Final Test (continued)

23. Name two of the four tools of aeronautics. Write a one sentence description telling what each is used for.

    1.

    2.

24. Complete the chart below that tells about an airplane's rotational motions and control surfaces. Each box is worth _____ point(s).

How a Plane Moves

Rotational Motion	Control Surfaces

Aeronautics Final Test - Key

1.	true	6.	true	11.	A	16.	B
2.	true	7.	false	12.	C	17.	C
3.	true	8.	false	13.	A	18.	B
4.	false	9.	true	14.	B	19.	C
5.	false	10.	true	15.	C	20.	B

21. 1. state the problem (question)
2. form your hypothesis (prediction)
3. design an experiment (materials and procedure)
4. do the experiment (observe and record data)
5. organize and analyze data
6. draw conclusions

22. The following points should be found within the answers:
- Thrust for speed produced by engines or propellers.
- Wings at an angle to the relative wind.
- Airflow is faster over top and slower underneath which creates low air pressure area above the wing and high air pressure area below the wing.
- Perhaps a nod to Bernoulli and his principle regarding air pressure and air flow speed.

23.

1. computation	Computers are programmed with airplane design specifications and are "flown" in the computer. The computer tests the design for its aerodynamic features.
2. wind tunnels	A model of a new wing or airplane design is placed inside the tunnel and air is blown around it. Engineers check for the effects of lift and drag. They check to see if the model is aerodynamically sound.
3. simulation	A simulator's computer is programmed with an airplane's design specifications. A pilot then "flies" the simulator and gives feedback on how it handles.
4. test flight	A prototype is made of a new aircraft design and is actually flown by a pilot who then gives feedback on how it flies.

24.

How a Plane Moves

Rotational Motion	Control Surfaces
yaw	*rudder*
pitch	*elevators*
roll	*aileron*

25.

1. *drag* — *resists the forward movement of the airplane*
2. *lift* — *lifts the airplane in a direction perpendicular to the direction of thrust*
3. *thrust* — *gives it speed to move forward*
4. *weight* — *pulls the airplane towards Earth or in the direction opposite lift.*